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HABITAT RELATIONS OF THE GIANT KANGAROO RAT

BY JOSEPH GRINNELL

The giant kangaroo-rat was first made known to science by Dr. C. Hart Merriam (Proc. Biol. Soc. Wash., vol. 16, 1904, pp. 141–142) who called it *Perodipus ingens*, basing this specific name upon a specimen taken by Luther J. Goldman near Painted Rock, on the Carrizo Plain, San Luis Obispo County, California, August 6, 1903. Doctor Merriam's characterization of this new form as of "huge" size, "not only very much larger than the largest known species of *Perodipus*, but equaling *Dipodomys spectabilis*," is fully borne out by later findings—and even more, *ingens* proves to be decidedly larger even than *spectabilis*, as will be demonstrated in the present paper. Incidentally, since Merriam's writing, the "genus" *Perodipus* has been shown to be not separable—all the kangaroo rats are now included by most authors in the one genus *Dipodomys* (see Grinnell, Univ. Calif. Publ. Zoöl., vol. 24, 1922, pp. 1–124, pls. 1–7). Thus it can now be said that *D. ingens* is the largest form in the genus *Dipodomys*, which includes upwards of 65 valid species and subspecies.

But here is the surprising circumstance—that despite its large size and presumptively superior powers of locomotion, this rodent has an exceedingly restricted geographic range (see map, fig. 1). Yet within this narrow general range, along the southwestern side of the San Joaquin Valley, there are thousands of acres of land upon which *Dipodomys ingens* is the dominant rodent—it "owns" whole square miles to the practical exclusion of other seed-eating mammals. It is, moreover, a full species, a "*Linnaean*" species, in the sense that in characters it is sharply and constantly set off from any other kangaroo-rat; it has no

near relative out on the Mohave Desert, as have so many other Lower Sonoran vertebrates of the San Joaquin.

What are the particular habitat relations of *Dipodomys ingens* that can be detected and defined, and how may these be interpreted to account for the above facts in distribution?

In February, 1932, with Ward C. Russell as field assistant, I made a trip into the southern (upper) portion of the San Joaquin Valley, during which trip opportunity developed for making some observations upon the giant kangaroo-rat. Traveling from the west over Panoche Pass on

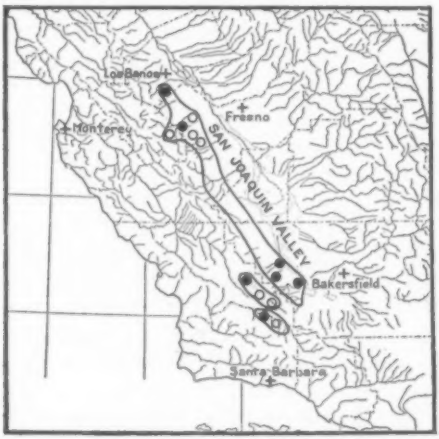

FIG. 1. MAP OF PORTION OF CALIFORNIA SHOWING LOCALITIES OF OCCURRENCE OF DIPODOMYS INGENS

Solid circles show places whence actual specimens have been examined by the author; open circles show other places, where "workings" have been seen by the author. Assumed general range outlined.

February 17, we first noted signs unmistakably of this rodent along the road over the bare, rolling hills at close to 1100 feet altitude, between Panoche Creek and Silver Creek, and thus a trifle over on the San Benito County side of the boundary between that county and Fresno County. (See Panoche quadrangle, U. S. Geological Survey topographic map.) That night we made camp on a spot which for the three succeeding days was the center of our study of *Dipodomys ingens*. This camp-site was on a very gently sloping piedmont plain, about 200 yards out from

the bases of the first hills to the west of the San Joaquin Valley floor; altitude approximately 600 feet, about one mile southwest of "B.M. 502" of the map, and about one-half mile southeast of a house shown on the map. This house, now well-nigh a wreck and likely soon to disappear as a landmark, is located on the brink of the bank of the "wash" from Panoche Creek and at the foot of the first hill south of this.

The whole country for miles around, for a long series of years, has been grazed by domestic sheep to the limit of its carrying capacity and there is much evidence that nowhere near as good grazing conditions prevail now as formerly. Indeed, much of the present barrenness of the hills immediately to the westward appears to be due to too intensive sheeping; long dead stubs of bushes show here and there in the now fast eroding soil of the steeper slopes. Yet here we found a rodent, a seed-eater to be sure, which was thriving, at least on the flat ground, despite the constant close grazing by the sheep. The ground immediately about our camp was well-nigh devoid of even traces of old vegetation, and the new green stuff was up scarcely an inch. Hoof-prints of sheep literally covered the surface of the soil, though there had been no grazing here since the new growth had started. A sort of clayey veneer forms over the soil surface in wet weather; then this sun-bakes. The ground surface is thus firm and permanent, not at all wind-moveable.

The burrow-mouths of *Dipodomys ingens* here we found to be mostly in small groups—of 2, 3 or 4; and these groups were far separated from one another. Sometimes there would be a single sequestered burrow, possibly a temporary, "duck-in" refuge; such we ruled out in making our estimates of rat occupancy. We staked off three randomly-selected, separated flat acres, and counted the groups of burrows on each, with results as follows:

Acre no. 1: 13 groups of 2 holes each, 9 groups of 3 holes, 6 groups of 4 holes, and 3 "singles." Since our trapping showed unmistakably not more than one adult rat per group, this could be taken to indicate a population of 28 rats on that acre.

Acre no. 2: 9 groups of 2 holes each, 6 groups of 4 holes, 5 groups of 3 holes, and 1 "single"—hence a possible population of 20 rats.

Acre no. 3: 8 groups of 2 holes each, 4 groups of 3 holes, 4 groups of 4 holes, and 3 "singles"—population on this acre, possibly 16 rats.

An average for these three acres was thus 10 groups of 2 holes each, 5+ groups of 3 holes, 5+ groups of 4 holes, and 2 "singles." This might mean an average population at this time of 21. Practically all groups showed one or more burrows with evidence of rat occupancy. It is

hardly conceivable, however, that at this season all the old precincts could have been occupied by adult rats; many individuals must have met death since a previous breeding season. I thought it possible that some of this year's young had already established themselves in old precincts, or else that some of the old rats were in the habit of visiting two or more precincts. Either consideration raises some doubt as to the above figure, based on group counts, being exact for population. Probably this 21-per-acre estimate is too high, at least for the minimum population in the annual cycle, even though not high enough for the maximum. Using this figure as basis, an estimate of 13,440 *Dipodomys ingens* per square mile is derivable.

A general survey of this particular neighborhood did not show any general "mounding" of the ground surface, as being due to the presence of the rats. The groups of holes, each group marking a "precinct" of under-ground burrowing as well as a focus of above-ground activity, were as a rule on flat-surfaced ground. However, it was noted that open burrows were rarely situated in depressions of the ground surface where such occurred, and where such might be inundated at rare times of sufficiently heavy rain.

Some of the burrow openings showing signs of fresh use were closed, as if from within, with loose earth. But most of the burrow-mouths were constantly open. I noted two distinct types of burrow openings, and there was always at least one of each type in each "group." In one type, the entry-way slanted downward gently, the mouth usually (but not always) facing a narrow "apron" of bare, and often freshly excavated, earth; this type of opening was usually wider than high. In the second type, the burrow reached the surface of the ground vertically, or nearly so, and the orifice was usually perfectly circular; and there was rarely any loose earth about it. It looked as though this type of burrow had been dug to the surface from beneath. There were, it is true, occasional burrows that were varyingly intermediate between these two types, but they were so few as not to affect the general application of the above defined classification. In taking the dimensions given in the next paragraph, I eliminated "intermediates," as also any burrow-mouths the orifices of which obviously had been modified by rain or by the hoofs of sheep.

On February 19 I measured 20 burrow entrances, each, of the two types described above. The average of the first type was 81 millimeters high by 89 mm. wide; of the second type (circular), 57 mm. Extremes in the first lot were: vertical diameter, 63 and 100 mm.;

transverse diameter, 70 (in a freshly dug burrow) and 110 mm. In the second lot, 17 out of the 20 were circular; the smallest measured 47 mm. across, the largest 65; but of the 3 that were not quite circular, the largest measured 60 by 80 mm., averaging 70 and thus the largest in this lot—and seemingly not adventitiously modified. Of course in all cases, only holes showing signs of current use (loose earth or claw marks) were measured. The texture of the soil here was marvelously suited to year-long maintenance of burrows—firm, holding together well, yet "diggable" for a rodent of weak fossorial power. Incidentally, it was easy to dig in with a shovel—no gravel, no stones to strike, no resistant "adobe;" yet no tendency to cave in, at least to the depth to which it was moist at the time of our investigations.

We dug out three precincts of *Dipodomys ingens*, selected because of typical and "used" appearance of entrances, plotting to scale the courses of the burrow systems of each precinct as we proceeded. Diameters, depths and other data were recorded. Considerations subsequently came to mind that make it seem not quite worth while to reproduce the plans of these burrow systems with this article. For one thing, in none of the three cases did we find an animal within. Although in each case we thought we had uncovered the entire system, there was a chance, I now think, that portions of the system had been walled off, possibly by the animal itself as we began to dig. Also, in none of these cases did we find a nest, such as experience had led me to expect to find. On the other hand, each system may have been quite complete as we uncovered it. It would have been possible for the occupant to whisk away at a time when both of us were intent on tracing and measuring one of the tunnel branches. Also there was the chance that the owner had been one of the animals trapped by us in the general neighborhood the preceding night. Nevertheless, the following findings, incomplete as they may be, are here presented as furnishing facts of interest concerning this species of kangaroo-rat. The exhaustive study of the "Life History of the Kangaroo Rat *Dipodomys spectabilis spectabilis* Merriam," by C. T. Vorhies and W. P. Taylor (U. S. Dept. Agric., Bull. 1091, 1922, 40 pp., 9 pls., 3 text-figs.), may properly be cited here in comparison with the present study of *D. ingens* as showing that, despite the far lesser degree of completeness of my study, certain sharply defined differences are indicated in the habits of these two species of the same genus.

In each of the precincts of *Dipodomys ingens* that we dug out, the system of underground burrows was dichotomous; that is to say, there was no labyrinthine re-connecting of tunnels. The tunnels also, though

varying somewhat in depth, did not extend one beneath another—there was no double-decking; and no great depth was reached anywhere along the tunnel-ways, 460 millimeters being the greatest depth we recorded. The maximum extent of the uncovered burrow system was, in each case, approximately 10 feet (3.25, 3.05 and 3.05 meters); this means the farthest distance apart of extreme portions of the burrow system, whether a blind tunnel-end or a burrow entrance. Two of the systems showed 2 surface openings, one 3 such openings. "Aprons" of bare or loose earth opposite the open mouths of four of the openings measured: 400 (out from mouth) by 120 millimeters, 625 by 625, 410 by 120, and 700 by 300. Twenty-three depths taken along the underground passage-ways averaged 263 mm. (thus less than one foot); the greatest depth was 460 mm. The tunnels ordinarily varied in diameter between extremes of 50 and 75 mm. But there were occasional enlargements, surely not cave-ins, up to as great a diameter as 150 mm.; these contained no nest material.

The total lengths of tunnel, including side-branches as well as main passage-ways, were, for the three precincts excavated, approximately 30, 24, and 27 feet. There were 10, 7, and 8 points of forking in the three precincts, respectively; but most of the forkings were for short diverticula from a main passage-way. On the floors of some of these blind branches were small collections of "greens" (fresh pepper-grass), but otherwise no food-stores were found. But in some of the apparently filled-in continuations of tunnels, or sections of same, mixed in with the loose earth, were quantities of grass-seed hulls and other plant refuse, indicating a late-summer or autumnal gathering of food from plants not recognizable by us as represented in the new growth then starting. No accumulations of excrement were found anywhere within the tunnel systems. The characteristic, jelly-bean-shaped, fecal pellets (7 by 2.5 mm. in dimensions) were, however, to be found above ground, widely scattered over the "aprons" in front of burrows and along the regularly traversed paths from precinct to precinct.

A circumstance of seeming significance was that the winter rains had as yet conspicuously wetted the ground to a depth of only 220 to 230 millimeters. The greater part of the underground system of the rats lay below this level, hence in relatively dry soil. Indeed, the loose earth in some of the filled-in, as we thought, blind extensions of tunnels 250 or more millimeters deep was so dry that, tossed into the air, much of it drifted away as dust. The consistency and considerable volume of this loose, dry earth as encountered by us, often mixed with seed-hulls,

suggested that the animals had dug repeatedly and hence more and more easily back and forth in it. Also there was the greater chance easily to wall off sections of tunnel in the face of danger, though I have nothing else to offer in support of this idea. There is, however, pretty strongly upheld, the theory that *Dipodomys ingens* finds optimum conditions for burrowing in a belt of country where the rainfall (5 inches or less per annum) is not sufficient to wet the ground thoroughly, between the long dry seasons, to a depth greater than the animals can easily exceed in their digging. In other words, no matter how wet the ground at the surface becomes for brief periods at long intervals, during those periods this xerophilous rodent can find access to almost or quite dust-dry earth in some part of its burrow system. This factor might conceivably be a vital one for the welfare of the species and hence be an important one in geographical limitation. The prime basis for the presence of this particular rodent would thus be a rainfall within some certain annual maximum, plus a particular kind of soil as regards permeability by water and diggability by the animal.

I saved what I judged to be a fair sample of the soil (and everywhere on flat ground it looked to me to be uniformly the same) from within 6 inches of the surface, where *Dipodomys ingens* had been digging, and submitted this for identification to Dr. G. B. Bodman, Associate Professor of Soil Technology, University of California. He pronounced it to be "Panoche loam" or "Panoche [fine] sandy loam." Referring to a paper by C. F. Shaw entitled "Basis of Classification and Key to the Soils of California" (Proc. and Papers, First Internat. Congress Soil Science, IV, 1927, pp. 22–23), this diagnosis indicates the position of this soil to be as follows: Secondary (order); Cum-calcis (class); Division C-D, from disintegrated and decomposed sandstone, shale and limestone rock sources; Family, lime hardpan; Stage, young; Group, gray. A soil map inclusive of a part of the known geographic range of *Dipodomys ingens* is contained in a pamphlet entitled "Reconnoissance Soil Survey of the Middle San Joaquin Valley, California" (U. S. Dept. Agric., 1919, p. 81 and map). On this is marked the areas of occurrence of Panoche fine sandy loam; and the striking thing indicated is, that these areas, here and there along the western margin of the San Joaquin, include most of those in which *D. ingens* has been found. I did not know about this map when I was in the field; future work is urgently suggested in the tracing and verification or disproving of this seemingly strong correlation.

We found evidence of the presence of only two animals that prey

upon *Dipodomys ingens*; but these enemies must be potent, as they were probably well-nigh dependent upon the kangaroo-rats for food in this territory at the time we were there. Coyotes (*Canis ochropus*) were heard yelping nightly, and diggings of theirs, from a depth of a few inches to two feet or more, into *D. ingens* precincts were found in several places, with footprints and claw-marks of the coyote showing in the freshest of these diggings, made the night before. Whether the coyotes actually catch any of the rats directly by digging them out can only be surmised, although digging in the type of soil present was evidently easy and therefore rapid. A comment to us by a lone rancher a mile or two away was significant in this connection. He said that when he runs a tractor over new ground he sees lots of the kangaroo-rats; "the vibration scares them out of the ground!" Possibly a coyote is now and then able to capture a rat "scared" out by the digging, as it dashes from the one precinct to another—at least often enough to make this mode of hunting "pay."

The other apparently regular enemy of the kangaroo-rats was the great horned owl (*Bubo virginianus pacificus*), the notes of which we heard every night. In five instances kangaroo-rats caught in traps set along the bases of the first hills were eaten, I believe, by owls of this species. The remains of the rodents consisted of most of the skin, parts of the head, and most or all of the intestines. In each case they had been dragged away from the places where the traps had been set, and the limy, semi-liquid excrement of the owls was scattered about, twice actually on the trap itself. It is not unlikely that the rats had been pounced upon by the owls when still alive and moving about. In any event the trapped animals could surely be seen at night, and possibly heard, a long way on the open ground surface devoid of a wisp of cover.

Mr. Russell was accustomed to visit his trap-line after night-fall. On the evening of February 19, the first rat was caught at 7:30. A little later, two were seen by spot-light, one sitting momentarily at the mouth of a burrow, the other hopping rapidly toward a burrow and not hesitating when "flashed." The impression was gained that they were exceedingly wary.

We were impressed, further, by the regularity in the spacing apart of the precincts (sets of 2 to 4 burrows marking each "precinct"). This regularity suggested the operation of a "territoriality" factor, determined by year-through minimum of subsistence provided on this terrain, and forage-range capabilities, combined with fair success in eluding enemies. Even though the close "sheeping" and the new green growth

had mostly obliterated the paths, traces of these could be detected between adjacent precincts, and from one precinct to another, almost indefinitely. In some places the paths went up rather steep hill-slopes, diagonally or even straight up-hill. These much-trodden pathways doubtless become much more conspicuous after active growth of the annual herbage has ceased. In this connection, it should be emphasized that on this *ingens*-"owned" terrain, we caught not one other kind of rodent, and not a sign of ground-squirrel or rabbit was seen. A total of 175 trap-nights brought 36 *Dipodomys ingens* (not all saved as specimens) but nothing else. Over in the "wash" from Panoche Creek, of totally different habitat character (heavy *Atriplex lentiformis* brush, etc.), there were other mammals—four other kinds of rodents trapped by us, including a race of the small *Dipodomys nitratoides*. The giant kangaroo-rat shows a remarkable "exclusiveness," an ability to appropriate suitable ground for its sole occupancy, possibly by direct action, and yet a curious inability or disinclination to invade near-by areas of differing character of soil or of flora.

As to the animals' food our brief study brought relatively meager indications. Quantities of hulls and shells of seeds of grasses and other plants were found in the burrow-systems excavated, pointing toward a period of ripe-seed harvesting in summer and fall. But no unshelled seeds were found. The cheek-pouches of the animals trapped were mostly empty; but in a few cases they were filled, even to capacity, with green-stuff. The greater portion of this consisted of nearly entire plants of the common pepper-grass, identified for me at the University of California Herbarium as *Lepidium nitidum*. At this time (February 18 to 20) pepper-grass constituted the first and dominant seasonal growth of annual vegetation, following the mid-winter rains. In places it formed a velvety carpet, and although only an inch high or less, it was blossoming, and some of the new seeds were already "set." True grass was sprouting here and there, doubtless to form a later "crop;" and some filaree was growing where the little, eroded, rain-water gullies debouched upon the plain at the foot of the hills. Cheek-pouches of the rats held, besides the pepper-grass, scraps of leaves of young filaree, and of an undetermined sprouting plant. Those trapped animals that held anything in their cheek-pouches were adult males, adult females, and one two-thirds-grown female. The three individuals whose cheek-pouches were literally crammed with green-stuff were old females showing indications of nursing.

Strangely, none of the cheek-pouches contained bait, although at

first we baited our traps copiously, both scattered (loose), and "chewed" (saliva-moistened) on-the-treadle. Baits tried included corn-flakes, rice, and corn-meal. The kangaroo-rats were simply not interested in grain-bait; the newly appearing "greens" served adequately to meet their nutritional needs at this particular season. Could there be significant correlation of this food preference with season of nursing and of the launching of the young into food-getting independency?

The first night, we put out 57 baited rat-traps, each placed on the surface of the ground in the path in front of a burrow showing marks of immediate occupancy. We got 5 kangaroo-rats, which seemed a poor showing in view of the abundance of sign. Thereupon, Mr. Russell developed a special method of trapping; using this method, the third night he got 11 with 33 traps. His method was to in-set (bury) each trap in a cut-out place so as to be flush with the surface of the ground, in a pathway 12 to 15 inches in front of the mouth of a main used burrow of a precinct, sprinkling the whole with loose earth so as nearly or quite to conceal it, yet leaving the treadle free, but using no bait. The trap would be so placed, either crosswise or lengthwise of the path, that the treadle would occupy a mid-position in the path, and so be hit by a rat whether going out of, or coming into, the burrow. Mr. Russell also tried Macabee gopher traps, set within burrows, but the mangling of the animals so caught reduced their value for specimens. In one 4-hole precinct, a gopher trap was set in each of the four holes, but only one rat was caught, and no other trap sprung. This and all the other evidence, as elsewhere stated, indicated that each precinct harbored permanently but one adult animal. The breeding data now available are too fragmentary to be really satisfactory for generalization. But certain peculiarities of this species as among kangaroo-rats in general are indicated. Three of the females collected at the Panoche Creek locality on February 19 and 20 were pregnant. Each contained five foetuses; the diameters of these were 8, 10 and 30 millimeters, respectively. This potential number of young at birth (even an instance of six, as given below) is extraordinary in *Dipodomys*; the usual number is 2 or 3, and I do not recall an instance of more than 4 in any species. That all of five embryos would develop to the stage of birth, or that all of five young, if born, would grow to maturity, is problematic; but the same considerations, though in probably different degree, would pertain to the records of 2 or 3 embryos. At any rate, in this locality, at this time, a reproductive potency of three and one-half-fold would appear to have been reached.

Nursing females showed 6 nipples, one pair pectoral and two pairs inguinal. All the nipples showed signs of having been suckled, each being elongated, rather horny to the touch, and with a nearly bare space around it.

At the same place (Panoche Creek) and time (February 19 and 20) we trapped seven young. Four of these preserved varied in weight from 77.4 to 103.5 grams. The largest, a male, may be taken to indicate the earliest breeding this year, which I would guess as having been about the middle of January (when, by the way, probably no new vegetational growth at all had yet started). A total breeding season of some length is thus suggested, probably January to May. This is borne out by other data in the Museum of Vertebrate Zoology. In 1911, May 18 to 21, H. S. Swarth collected 20 specimens of *Dipodomys ingens* near McKittrick, Kern County. Of these, 5 were adult (1 male, 4 females) and 15 were young. The smallest of this lot of young was much smaller than the smallest taken at Panoche Creek; its weight was not recorded, but in total length it measured only 236 millimeters. The most surprising record of Mr. Swarth's is of a female taken May 18, containing 6 embryos. As above indicated, this stands now as the maximum number of foetuses known to me in the genus *Dipodomys*.

While, for some unknown reason, among the adults collected by Mr. Russell and myself in February at Panoche there was remarkable disparity of females (16 males to 8 females), the sex-ratio in the records of 21 young now available indicate a nearly equal sex ratio (10 to 11).

In April, 1912, I made a trip through the Carrizo Plain and Cuyama Valley country. Both names apply to broad, open plains somewhat detached by ranges of low mountains from the main San Joaquin Valley; and although elevated, they possess many Lower Sonoran plants and animals. In parts of both valleys I found extensive populations of *Dipodomys ingens*. Writing in my notebook on April 24 of that year, at 9 a.m., when making observations from the south slope of Caliente Peak, which is on the north side of Cuyama Valley, I made record substantially as follows: "The Cuyama Valley floor spread out below me toward the Cuyama range of mountains is bare and grassy, save for some tracts of arrow weed and atriplex, mostly near the 'river.' The grass-covered gentle slopes opposite me, extending up to the bases of the Cuyama Mountains [thus mostly across the county boundary, in northern Santa Barbara County] are strikingly and evenly marked with darker green spots, which my explorations yesterday showed to be the workings of *Perodipus ingens*. From a distance of two or three

miles the even spacing of these patches is sharply in evidence over a large area. The darkness of the spots is due to the ranker growth of the grass where the ground has been worked over by these animals."

On April 25, I trapped two adult female *Dipodomys ingens* on pasture-land on the San Luis Obispo side of the Cuyama River, which here forms the county boundary. This was about a mile west of "B. M. 1935," of the Santa Ynez quadrangle, U. S. Geol. Surv. Here I wrote: "The *P. ingens* close most of their burrows at night; some look as though they had been filled from without—patted down, as it were. The burrows are large, fully three inches in diameter. Over thousands of acres the 'colonies' are spaced out over the level or rolling cattle-range, this being here apparently the only rodent, taking the place of the ground squirrels elsewhere." [Those "colonies" I now think each represented the set of burrows belonging to one kangaroo-rat.]

On April 27, 1912, I traversed from southeast to northwest the Carrizo Plain, which lies at an average altitude of 2000 feet in eastern San Luis Obispo County. Near the Kern County Land Company's ranch at the north base of Caliente Peak I wrote: "*P. ingens* occupies hundreds of acres of the higher level or hummocky ground here, now green, but it does not extend down into the alkali ground of the lowest 'sink.' I measured the diameters of fresh, open burrows; twelve of them averaged 74 millimeters, extremes, 60 and 90 mm. In the freshly thrown-out earth I saw many of the 50-mm. hind-foot tracks which, additionally, distinguish *ingens* from any other kangaroo-rat [of west-central California]."

From March 31 to April 2, inclusive, 1932, I traversed the western edge of the San Joaquin Valley from Coalinga, Fresno County, to Los Baños, Merced County, keeping more or less close along the bases of the foothills. I did not find signs of *Dipodomys ingens* continuously, indeed nowhere in the immediate vicinity of Coalinga; but they were common here and there south of Panoche Creek for about 9 miles, at altitudes between 400 and 600 feet. The most interesting result of this trip was the finding of this animal, in just about maximum abundance for the species, in Merced County about 12 miles due south of Los Baños, to date the most northern known station for it. This is where Laguna Seca Creek (a deep gully, no "wash," and no water at that time) cuts out of the first foothills through a gently sloping piedmont plain, 400 feet altitude (see Panoche quadrangle, U. S. Geol. Surv.). Two specimens were preserved and observations recorded, as follows.

As in the Panoche Creek locality, *Dipodomys ingens* here seemed to be

the dominant rodent. I saw no ground squirrels or any signs of pocket gophers on the territory occupied by it. Signs of the presence of the *Dipodomys* might not have been quickly recognizable, though through incidental circumstances they were conspicuous. By this I mean that the actual burrow-mouths and pathways of the rats were for the most part completely concealed or effaced by the new vegetation, yet each rat's precincts stood out plainly by reason of the lushness and greenness of the growths upon them. Included in these growths was much brilliantly green filaree, some of it up to 16 inches tall; little or none of this plant grew on the intervening ground, which was occupied by a close, low growth of pepper-grass, now already brown, and in places by flowering "goldfields"—a plant that comes in later than the pepper-grass. Thus, again, each rat's precincts were marked by a conspicuous "green" some 2 to 4 yards across and far separated from its neighboring "greens." Pacing showed these "greens" to be 20 to 30 paces apart, and pretty regularly spaced accordingly. About two-thirds of the "greens" examined did not show evidences of present occupancy of the holes that all of the "greens" showed. From this it can be inferred that only about one-third the population at a previous annual maximum had persisted clear through to the beginning of the current breeding season—which on April 2 was well under way, for I caught an 82-gram youngster.

The precincts that were currently occupied showed quite as lush growth of vegetation as those from which the rats had disappeared. Even in these occupied "greens" the trails were distinguishable only a foot or two out from the actual mouths of the burrows, their floors having grown up to pepper-grass, etc. Some of the used entrances were so grown over by filaree and grass as to make their approaches tunnel-like, suggesting giant meadow-mouse runways. Of course, as the long, dry, hot summer season came on, the vegetation everywhere would shrivel up, the appearance of green spots would vanish, the burrow-mouths would come into conspicuous view, and the interprecinct paths would become pronounced.

The soil here, again, was fine sandy loam, rather easily diggable. One "green" showing fresh signs was excavated, disclosing an extensive system of burrowings. In one section of tunnel, 330 mm. beneath the ground surface, was a mass of nest material consisting of a dry mixture of sheep's wool, fine shredded dead grass stems, and seed hulls—about a pint in total bulk; but there were no young in it and some of the diverging tunnels were "lost." The adult male trapped, at another "green" showing fresh sign, held in its cheek-pouches ripe or nearly ripe

seeds of pepper-grass, filaree, and a true grass of some kind; also some fragments of green filaree leaves.

"Size" of any kind of animal may perhaps be most satisfactorily judged from weights taken of as many individuals as are available for the purpose. Mr. Russell and I preserved 22 adult skins-with-skulls of *Dipodomys ingens* from the one, "Panoche Creek" locality, ascertaining the weights (cheek-pouches emptied) and external measurements of each. As to weights, the 15 males averaged 157.0 grams (extremes 140.0 and 174.2); the 7 females averaged 151.4 (130.8 to 180.0); average of all 22, 154.2 grams. Curiously, the heaviest as well as the lightest is a female; and the lightest was pregnant, the heaviest was not!

It is interesting to compare these figures with those of the two next largest species of *Dipodomys*. Among 63 adult specimens of *D. deserti* in the Museum of Vertebrate Zoology from southeastern California and southern Nevada, 33 males average 118.4 grams (91.0 to 148.0) and 30 females average 107.3 (88.8 to 136.5); average of all 63, 113.1 grams. For *D. spectabilis* from Arizona, Vorhies and Taylor (1922, p. 7) give "the average weight of 29 adult specimens of both sexes" as 114.5 grams (98.0 to 131.9). It will thus be seen that the Californian *D. ingens* is much the "biggest" and well warrants the name C. Hart Merriam gave to it.

As to dimensions, our 22 adult Panoche Creek specimens provide the following figures. The 15 males: Total length, 332.9 mm. (312–347); tail vertebrae, 181.2 (157–197); hind foot, 50 (48–51); ear from notch in 13 specimens, 17 (16–18.5); ear from crown in 2 specimens, 14; greatest length of skull, 45.9 (44.0–47.5); breadth of skull across bullae, 29.5 (28.1–30.4); greatest spread of maxillary arches, 27.0 (26.2–28.3); greatest length of nasals, 17.1 (16.3–18.0); greatest width of rostrum, near end, 4.9 (4.6–5.4); width of maxillary arch at middle, 6.2 (5.5–7.0). The 7 females: Total length, 334.4 (323–348); tail vertebrae, 185.7 (179–194); hind foot, 50 (46–52); ear from notch in 5 specimens, 16.7 (15–18); ear from crown in 2 specimens, 14; greatest length of skull, 45.1 (43.6–46.0); breadth of skull across bullae, 29.0 (28.4–30.0); greatest spread of maxillary arches, 27.1 (26.5–27.5); greatest length of nasals, 17.0 (16.2–17.4); greatest width of rostrum, near end, 4.6 (4.4–4.8); width of maxillary arch at middle, 6.4 (6.0–6.7).

It would appear that, in *Dipodomys ingens* as in other kinds of kangaroo-rats, males and females are closely alike in measurements. Certain differences are apparent, but the number of individuals measured is too small to make these differences truly significant. Judging from

weights and dimensions together, this species in comparison with the next largest species in the genus is of notably "heavy set" build.

Although the foregoing account of the natural history of the giant kangaroo-rat is obviously fragmentary—far better methods than I employed for field study of the animal could be devised and carried out, especially with adequate time in which to do it—enough is here put on record to suggest certain conclusions, as follows:

Dipodomys ingens is the largest known species of the genus; ascertained weights of adults average 154.2 grams, as against 114.5 grams in *D. spectabilis* and 113.1 grams in *D. deserti*.

The species has an exceedingly restricted geographic range, comprising a narrow strip of territory along the southwestern margin of the San Joaquin Valley and certain small higher valleys immediately to the westward (see map, fig. 1). Yet despite this geographic restriction it is individually numerous—by estimate based upon counts of "precincts" on optimum ground, 21 per acre.

From two to four burrow-mouths mark the location of an underground system of tunnels, all together comprising a "precinct" which is occupied by but a single adult animal. The underground system of burrows is shallow, on approximately one level, yet rather extensive. The precincts are spaced apart on level land with remarkable regularity; they do not, *per se*, account for any general mounding of the ground surface, though low places seem to be avoided. There is no correlation of their location with the presence of shrubs or bushes; indeed, *Dipodomys ingens* seems definitely to avoid cover of any sort—it is a rodent of perfectly open terrain, and where conditions are suitable it "owns" the territory to the practical exclusion of other seed-eating mammals.

Each precinct at the height of the growing period of the main crop of annual vegetation is marked by a brilliant green area 2 to 4 yards across, due to the much more lush growth and different flora there from that on the undisturbed ground between the precincts.

While the evidence shows the food of *Dipodomys ingens* throughout the greater part of the year to consist of seeds, marked preference is shown for green-stuff at the time when the new crop of annual plants is actively growing; and this time appears to coincide with the height of the breeding season of the animal.

Indications point definitely toward two regular enemies of this rodent, the coyote and the great horned owl; there are doubtless others. A "working adjustment" to these natural enemies is seemingly maintained by the kangaroo-rat through its individual equipment for rapid locomo-

tion; through its probably high development of the senses of hearing and sight; by the construction of its burrow systems, with two or more entrances (or exits) and with accessory "duck-in" burrows here and there; by the habitual use of well-defined pathways far and wide over its exposed forage grounds and between precincts; and through an unusually high breeding rate.

The facts and considerations here set forth make it seem likely that the sharp geographic limitation of *Dipodomys ingens* is to be accounted for by a complex of factors inclusive of: (1) Climate with a long, hot, dry season and with a brief growing season productive of a crop of annual plants of kinds yielding an abundance of seeds; (2) rainfall of five inches or less per year; (3) open, usually flat terrain, of non-alkaline soil of a uniform and peculiar consistency, a kind of fine sandy loam—diggable by an animal of relatively weak fossorial equipment, yet firm, not wind-driftable—soil which under the condition of low rainfall is not wetted to a depth as great as that reached in the relatively shallow burrow-systems of the animal in question.

Museum of Vertebrate Zoology, University of California.

THE MAMMALS OF THE MALPAIS, AN AREA OF BLACK LAVA ROCK IN THE TULAROSA BASIN, NEW MEXICO

By G. W. Bradt

As a member of the University of Michigan-Walker-Harris Expedition of 1927, the writer became interested in the mammals of the Malpais lava bed area lying in the Tularosa Basin just west of Carrizozo, Lincoln County, New Mexico. The expedition was able to spend but a single night at Malpais Spring,[1] which lies at the extreme southern end of the lava bed, yet the trap lines operated on this one night resulted in the discovery of a new subspecies of pocket mouse and a new subspecies of woodrat. The pocket mouse has been described by L. R. Dice as *Perognathus intermedius ater*, and the woodrat as *Neotoma albigula melas*.[2] Both the pocket mouse and the woodrat are very dark in color, much darker than the related forms found in the surrounding region. This dark color, corresponding to the dark color of the lava beds themselves, suggested further work in the area. The writer returned to the lava beds for parts of the two succeeding summers, and obtained additional specimens of each of the new subspecies named, as well as various other small mammals.

The time actually spent in work on the lava bed was too brief, and the season, late July and early August, too unfavorable, for the securing of conclusive data on mammalian distribution, or on the relationships of the mammals of the lava to those of the adjacent areas, but some of the results obtained were interesting, and may stimulate further work in the region.

Lava beds in the west are often termed "Malpais," a Spanish word meaning "bad country." The Malpais west of Carrizozo certainly merits this name, for it is a jagged mass of black rock, almost impassable even on foot, and used only to a limited extent as a goat pasture. A road has recently been completed across the Malpais from Carrizozo to Socorro, and is expected to attract travelers on account of the unusual

[1] Dice, L. R. 1930. Mammal distribution in the Alamogordo region, New Mexico. Occas. Papers Michigan Mus. Zool., no. 213, p. 12.

[2] Dice L. R. 1929. Description of two new pocket mice and a new woodrat from New Mexico. Occas. Papers Michigan Mus. Zool., no. 203.

type of scenery. The lava bed has a length of 44 miles, a maximum width of $5\frac{3}{4}$ miles, and an area of about 120 square miles. It extends in a southwesterly direction along the main axis of the Tularosa Basin. The lava seems to have issued from a crater near the north end of the bed, and probably also from other vents now concealed, and flowed down the basin in a ribbon-like sheet. A study of the surrounding features shows conclusively that the lava is of recent origin, and has been formed since all the present hills and ravines came into existence. Its age is estimated by Meinzer and Hare[3] as at least several hundred years, but probably not more than a few thousand years at most. It is, therefore, very recent geologically, having been formed in Post-Glacial time.

The surface of the lava bed descends toward the south at an average rate of about 30 feet to the mile, thus producing a difference in elevation between the north and south ends of about 1200 feet. This difference in elevation is sufficient to show marked differences in vegetation; junipers, for instance, are characteristic plants toward the north end, but disappear entirely toward the south end.

The margin of the lava bed is a rugged cliff or steep slope ranging in height from only a few feet to nearly fifty feet. The surface of the bed is exceedingly rough. It is practically impassable for horses or cattle, and man must be content with a very slow and arduous passage on foot. Smooth tracts of ropy lava are suddenly interrupted by abrupt pits, chasms, and caverns, ranging from five feet to a hundred feet in depth, or by masses of jagged fragments piled in chaotic heaps over the surface. Travel across the Malpais must be indirect, as no straight course can be laid out and followed. Detours of half a mile may be necessary in order to reach an objective but a few rods distant. Small islands of characteristic desert soil are found within the lava bed, apparently caused by the lava's having flowed around a slight ridge or other obstruction.

In the crevices of the lava, pockets of soil have collected, and the sparse vegetation of the Malpais grows in these pockets. Near the north end of the lava the juniper, while nowhere really abundant, grows sufficiently to give a characteristic appearance to the area. The junipers become stunted as the elevation drops; they disappear entirely toward the south end, where mesquite grows better, and in turn becomes

[3] Meinzer, O. E., and R. F. Hare. 1915. Geology and water resources of Tularosa Basin, New Mexico. U. S. Dept. of Interior, U. S. Geol. Surv. Water Supply Paper No. 343, pp. 34–40.

the dominant type of vegetation. Several kinds of cactuses, small shrubs, and short grasses occur wherever a little soil has collected. Mammalian life is necessarily limited here, but it is by no means absent.

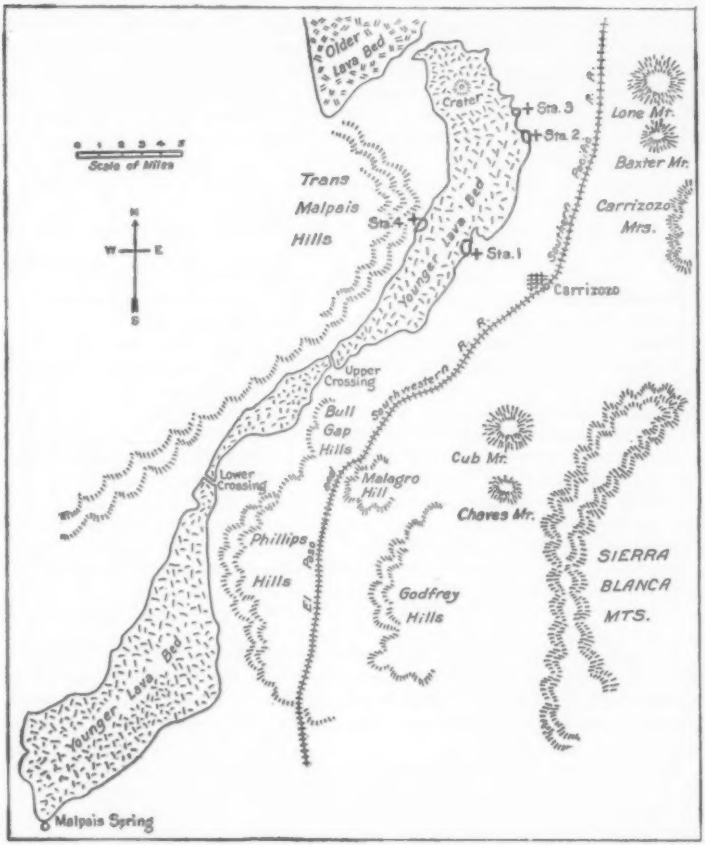

FIG. 1

Persistent trapping always results in the capture of small mammals. Trapping was carried on by the writer at four stations on the Malpais. These stations are indicated on the accompanying map.

Station 1 was located four miles northwest of Carrizozo by road, near the Angora goat ranch managed by John B. Coon. Traps were set in crevices and under bushes on the surface of the lava, and on the earth floor of the goat corral, which was merely a small islet of desert soil, entirely surrounded by lava. Any mammals living on the desert soil of the corral must have wandered in across the lava from the desert, a distance of about ten rods. The vegetation of the corral was exceedingly scant, because of the occasional presence of the goat herd. A few strands of barbed wire surrounding the islet enabled its use as a goat pen when desired. Since traps were set on the lava and also on the soil of the corral, the animals taken might represent both the lava dwellers and the desert dwellers which had wandered in from the nearby desert.

TABLE 1

Mammals taken on the Malpais

	STATIONS				TOTALS
	1	2	3	4	
Neotoma albigula melas	4		1		5
Neotoma micropus canescens				1	1
Peromyscus eremicus eremicus	2				2
Peromyscus truei truei	6	2			8
Peromyscus nasutus griseus	4				4
Perognathus intermedius intermedius	3		8		11
Perognathus intermedius ater	9	4	1	3	17
Perognathus flavus flavus	7	1		2	10
Dipodomys ordii ordii	1	1			2
Ammospermophilus interpres	1		1		2
Otospermophilus grammurus tularosae			1		1
Totals	37	8	12	6	63

The animals taken at station 1 included the dark Malpais woodrat, the cactus mouse, the pinyon mouse, the long-nosed deer mouse, the rock pocket mouse and its dark form, the Malpais pocket mouse, the Baird pocket mouse, an antelope chipmunk, and an Ord kangaroo rat. Scientific names of these animals are given in Table 1.

Station 2 was located 12 miles northwest of Carrizozo by road, at a point where the lava was very rough, and the junction with the desert floor markedly abrupt. The edge of the lava formed a cliff about 20 feet high. Traps were set in crevices along the cliff, and in suitable places on the lava above the cliff, within a few rods of the edge. Hence only true lava dwellers would be expected in the traps at station 2.

Animals taken at station 2 include the pinyon mouse, the Malpais pocket mouse, a Baird pocket mouse, and an Ord kangaroo rat.

Station 3 was located about one mile north of station 2, where the general condition of the lava was similar to that at station 2, but where the crevices and cav-

erns were even more extensively developed, and hence the hiding and nesting places more numerous. This station was at the nearest point available by road to the cinder cone from which much of the lava flow came. Traps were set in crevices and under junipers, starting at the edge of the lava and extending back over the surface of the lava in approximately a straight line to a distance of about 20 rods. Hence the animals taken at this station would be principally lava dwellers.

Animals taken at station 3 include the black woodrat, the rock pocket mouse and its dark form, the Malpais pocket mouse, an antelope chipmunk, and a rock squirrel.

Station 4 was located about ten miles from Carrizozo by road, across the lava bed, south of the new Trans-Malpais road between Carrizozo and Socorro. At this point the eastern slopes of the Trans-Malpais Hills are barren, rocky slopes, extending westward to the San Andreas mountain range. The traps here were set on the soil at the margin of the lava, and on the surface of the lava in a line extending for about ten rods back from the margin. Hence, both lava dwellers and wanderers from the hills might be taken at this station.

Animals taken at station 4 include the Malpais pocket mouse, the Baird pocket mouse, and a hoary woodrat.

The majority of the animals caught at these stations were taken alive and shipped to the Museum of Zoology at the University of Michigan. In all, 63 individuals were taken, belonging to 10 species. The black and the gray pocket mice, while quite different in external appearance, are considered merely as subspecies, *P. intermedius intermedius* being the well known rock pocket mouse of the region, and *P. intermedius ater* the black Malpais pocket mouse.

To the list of mammals found on the Malpais should be added the desert cottontail rabbit, *Sylvilagus auduboni minor*, as this rabbit is often seen on the lava beds. No attempt was made to capture these rabbits. As might be expected, many bats make their homes in the caverns of the Malpais. Those collected at Malpais Spring were identified as *Pipistrellus hesperus hesperus*, the canyon bat.

The mammals taken at the four stations described are listed in the following table, which includes those taken in 1928 and 1929.

This table shows that the animal taken in greatest numbers was the black Malpais pocket mouse, *Perognathus intermedius ater*. In addition to being taken most often, this mouse was also the most widely distributed, being the only animal taken at every one of the four stations, as well as at Malpais Spring. It is also interesting to note that not a single specimen was taken except on the lava. Traps set on desert soil in the goat corral at station 1, or on the soil a few inches from the edge of the lava never captured a black pocket mouse.

The animal taken in greatest numbers next to the black pocket mouse was the rock pocket mouse, *Perognathus intermedius intermedius*. It is significant that this mouse, so closely related to the black mouse, is a rock dwelling form found in the rocky slopes and canyons of the mountains. *Perognathus penicillatus eremicus*, the desert pocket mouse, was not taken at any point on or near the lava bed. The rock pocket mouse occurs both on the lava, and on the desert slopes fifteen to thirty miles away, but rarely, if at all, on the intervening desert.

Perognathus flavus, the little Baird pocket mouse, seems to occur in small groups here and there both on the desert floor and at the edge of the lava. None were taken on the lava more than a rod from the desert floor.

The cactus mouse, *Peromyscus eremicus*, was taken only on the desert floor of the goat corral, enclosed by the lava.

Peromyscus truei, the pinyon mouse, and *Peromyscus nasutus*, the long-nosed deer mouse, were taken on the lava as well as at the edge where desert and lava meet. These two species were taken indiscriminately in the same traps at station 1, so that no distinction can be drawn as to habitat preferences. The *Peromyscus* has been described as a new race—*P. nasutus griseus*—by Seth Benson.[4]

Neotoma albigula melas, the dark form of the white-throated woodrat, seems to be a characteristic type found only on the Malpais. It is closely related to *Neotoma albigula albigula* found on the rocky slopes of the mountains of the region. None of these normally colored animals have been taken on the lava.

The single specimen of the hoary woodrat, *Neotoma micropus canescens*, was taken at the edge of the lava where the Trans-Malpais Hills meet the Malpais, and was undoubtedly a stray from the canyons on the slopes of the hills. It occurs commonly on the sandy desert.

The Ord kangaroo rat, *Dipodomys ordii ordii*, was taken at station 1 and station 2, in each case on the lava, but within a few feet of the edge, and as their nests were observed a short distance away on the desert floor, it is probable that these individuals had wandered onto the lava temporarily.

The antelope chipmunk, *Ammospermophilus interpres*, taken near the edge of the lava, may also have been a wanderer from the desert sands, although several were observed, apparently living in crevices in the lava.

The rock squirrel, *Otospermophilus grammurus*, is probably a dweller among the rugged masses of lava although only two individuals were observed, one of which was taken as a specimen. This specimen was too young to show distinct characters plainly, but was decidedly dark. Seth Benson has since secured older specimens which are very dark, and which he has described as *Citellus grammurus tularosae*.[4]

The animals which have been taken on the Malpais and nowhere else are the dark forms of the white-throated woodrat, the rock pocket mouse, and the rock squirrel. The normally colored forms of the rock pocket mouse are found in the same places with the black types. The normally colored woodrats were not taken on the lava, although normally colored rock squirrels were observed, but not taken.

The peculiar dark forms of the pocket mouse and woodrat are more closely related to forms which are ordinarily dwellers on the mountain slopes fifteen or more miles distant from the Malpais, than to forms common on the desert surrounding the Malpais. The Malpais habitat is, of course, much more nearly comparable to that of the rocky canyons than it is to that of the open desert.

The only point at which rocky slopes approach the Malpais closely is along the western edge, near station 4, where there is scarcely space for a single track road between the Trans-Malpais Hills and the lava bed. At this point the rock dwelling mammals could gain access to the Malpais without crossing open sandy desert. As yet no systematic collections have been made in the Trans-Malpais Hills, nor in the San Andreas and Oscuro mountain ranges to the west, so that we cannot attempt to trace mammal relationships between these mountains and the Malpais.

On the east side of the Malpais there are no points of junction between the

[4] Benson, Seth. 1932. Univ. California Publ. in Zool., vol. 38, no. 5, pp. 335, 338.

mountains and the lava. The Sierra Blanca Mountains are fifteen miles distant across the desert. A few isolated hills lie between the mountains and the lava, but none of these are connected directly with the mountains, or with the lava. Hence, any mountain dwelling mammals in travelling from the mountains to the Malpais would be forced to cover five or more miles of open desert. The rock pocket mouse, the white-throated woodrat, the rock squirrel, and the pinyon mouse are all reported from the Sacramento Mountains east of Alamogordo.[5] There is no sharp distinction between the Sacramento Mountains and the Sierra Blanca Mountains, which lie immediately north of them, so that each of these forms is probably found on the mountain slopes of the Sierra Blanca range east of the Malpais. It would be advisable to do some collecting both on these slopes and on the slopes of the Oscura and San Andreas Mountains to the west, to determine the animal relationships existing between these ranges and the intervening desert and lava.

Immediately to the north of the present Malpais lava bed lies an older lava bed. This ancient lava bed might have been the place of origin for some of the dark varieties of mammals. The ancient beds are now greatly disintegrated, and mixed with desert soil. Even the outlines of the beds are almost indistinguishable. Only dark fragments of weathered lava scattered through the grass reveal the existence of the ancient flow. Unfortunately, no collecting was done in the area formerly covered with this older lava flow, so that no evidence for or against the theory that the dark forms originated there can be advanced.

The comparatively short period of time that has elapsed since the formation of the modern Malpais beds, not more than a few thousand years, and possibly even less than one thousand, might lead to doubt as to the possibility of development of several dark forms of animals within the time available. The ancient lava beds to the north, far older than the new flow, and separated from the latter in places only by a few rods, afford grounds for placing the origin of the dark forms farther back in time, and covering a much greater period of years.

Of the nine species of mammals captured on the Malpais, five were taken in sufficient numbers or observed in such ciruumstances as to lead to the conclusion that they are normal dwellers on the lava. These include *Neotoma albigula melas*, the black woodrat; *Peromyscus truei*, the pinyon mouse; *Peromyscus nasutus*, the long-nosed deer mouse, *Perognathus intermedius*, the rock pocket mouse; *Otospermophilus grammurus tularosae*, the rock squirrel; and *Ammospermophilus interpres*, the antelope chipmunk. The latter is included in this group of lava dwellers on the basis of numerous observations, in addition to the two specimens actually collected. These animals were often seen among the lava rocks, several rods from the edge adjacent to the desert. The Baird pocket mouse, *Perognathus flavus*, is not considered a true lava dweller, as it was taken only on the desert floor of the goat corral, or within a rod of the desert bordering the Malpais. Of the five species considered as true lava dwellers, three have been shown to be represented by dark varieties. These are the black woodrat, *Neotoma albigula melas*, which has been taken solely on the lava; the black Malpais pocket mouse, *Perognathus intermedius ater;* and the dark rock squirrel, *Otospermophilus grammurus tularosae*.

[5] Dice, L. R. 1930. Mammal distribution in the Alamogordo region, New Mexico. Occas. Papers Michigan Mus. Zool., no. 213.

No specimens of the normally colored woodrat have been taken on the Malpais. The gray and black forms of the rock pocket mouse were taken in the same trap on some occasions. However, the dark pocket mice were apparently more widely distributed and more abundant on the lava than were the gray forms. Observation indicated that the normal and dark forms of the rock squirrel were found together also.

The occurrence of several dark colored forms points to some direct relation between the color of the animals and the color of the rocks. Where normal and dark colored animals both occur on the lava the dark colored individuals tend to predominate in abundance. Presumably the dark color is an advantage to mammals living on the dark colored rocks, and would be subject to the action of natural selection. The fact that these small mammals are largely nocturnal in habits does not alter the possibility of the dark color's being beneficial to the animal, because their color still blends much more perfectly with the dark rock background than does the gray color of their competitors. This is quite noticeable on a bright moonlight night, when a gray object moving over the rocks is easily seen, and a dark object moved in the same way is practically invisible.

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IN PURSUIT OF BADGERS

By Tappan Gregory

[*Plate 15*]

We were a little surprised to be greeted as early as September 4, 1929, with a blizzard at Sportsman Lake. The Lake lies in the northwest corner of Yellowstone Park in Montana. Wetmore Hodges and C. H. Hodges, Jr. were my companions. On the trip in, two moose had slipped away, giving us only a glimpse, and elk were bugling nearby. Many had left their tracks in the trail, where a coyote had also passed quite recently. Three marmots took advantage of the last fair weather before the snow to loll about near their burrows, close to the lake. One posted itself on top of a big rock; two others sat in the mouths of their dens. At a sudden shrill whistle from one of their kind, both of the latter straightened up with forepaws held against stomachs.

In the elk country, at 9,000 feet, we saw no game the first day, save what we took for a young gray wolf. After the snow, we found a few elk, and coming out from our wintry quarters, fresh tracks of bear on our trail.

On September 7, we moved to Ernest Miller's Ranch on Madison River in Madison County, where a jackrabbit greeted us, bouncing along with white ears flashing, coming down stiffly on his forelegs, flexing his forefeet as he pushed off for each new jump.

Miller's Ranch borders on a sizeable lake, made by the damming of the river for water power purposes. Here the altitude is about 4,200 feet. The property extends back to the foothills in a series of benches, cut by numerous gulches, and watered partly by means of irrigation ditches, and partly by streams flowing down from the mountains, making picturesque green stripes through the broad expanse of sage and bunch grass. The benches and gulches were well covered with badger and ground squirrel holes, and as an initial effort, we decided to set one camera at one of these badger holes, and another on a trail in a basin, a mile or so above the ranch house.

Meanwhile, the other three cameras had returned three jackrabbits, one of them flying along the trail at high speed. The camera at the

second badger hole was set with the trip wire led around a peg at the far side of the badger hole in the form of a V, so that if the animal came out of the hole and walked away in any direction except straight towards the camera, it would trip the flash. On the night after the set was completed, September 16, this camera recorded a cow, but on the next night a badger came out, took the most likely route, tripped the flash, and judging from his tracks, retraced his steps into the hole. Recurring visitations of birds and horses finally persuaded us that nothing more could be accomplished in this locality.

In Madison County again, in the fall of 1930, I had able assistance in camera trapping from Henry C. Hodges, William C. Hodges and Dana Souther.

I joined them at the Jumping Horse Ranch, 5,200 feet above sea level, in time to set the camera on September 12, at a hole apparently dug out the night before by a hungry badger. We were favored with clear, still, mild days and cool nights for a week or so, but after the trap had remained three nights untouched, we became suspicious that fresh diggings did not necessarily indicate occupancy. Accordingly, the camera was moved to an old, well-worn, large-mouthed burrow at the foot of one of the benches. Fresh tracks encouraged us. Nearby, another hole had just been dug, undoubtedly in an effort by the badger to make a meal off ground squirrels. That night nothing happened, but on the evening of September 16, at 7:40, we heard the flash. The scene next morning gave evidence of turbulent activity. Mouse tracks covered the ground under the camera and lamp, and those of a large domestic cat were everywhere. I feared from the signs that the mousing cat was our prize, in spite of Bill's confidence that he could identify badger tracks. He was right. The rightful owner and occupant had come first and the camera caught him as he emerged. On the nineteenth the set was moved back a little farther from the hole and the arrangement changed, but three more nights brought no more pictures.

Chicago, Illinois.

Upper.—White-Tailed Jack Rabbit in Full Flight
Middle.—Badger Emerging from Burrow
Lower.—The Badger that Preceded the Mousing Cat

UNIV. OF MICH.

ELK CALLS

By Olaus J. Murie

Voice and communication among animals command attention in any study of the life history of a species. During the investigation of the elk of Jackson Hole, conducted for some time by the Biological Survey, ample opportunity has been afforded to study elk calls and the following notes are a résumé of calls and a consideration of their meaning.

THE ELK CALF

The newly born elk calf is equipped with a lusty voice. When disturbed or alarmed, or when temporarily separated from its mother, the little one emits a loud squeal, high-pitched and often piercing. It is difficult to compare with other sounds, but the elk calf's call has often reminded me of a certain call of the flicker, the "zee-ah" of Bendire, although of course with much greater volume. The call of the elk calf may be written "E-e-e-e-e-uh!", and is sometimes short, sometimes long drawn out, depending on the feeling of the animal. In the normal course of calling to its mother, with no danger present, the sound is more or less as indicated above, moderately short. On the other hand, on occasions when I have seized a young calf for the purpose of tagging its ear, it often gave voice to its terror in a startling medley of squeals and prolonged screams, which would sometimes bring the mother on the run.

Apparently, when beside the mother and undisturbed, the calf may utter a somewhat different version of the call, more in the nature of a low bleat. Such calls are difficult to detect among the wild herds, but a captive elk furnished better opportunities. A young bull calf was taken June 6, 1928, and was raised at the Elk Refuge at Jackson, Wyoming. As the animal matured the baby calls persisted, although becoming deeper in tone. As late as August 21, 1932, when the animal was well over four years old, with its fourth pair of antlers, this low bleat or modified squeal was heard—an incongruous sound coming from such a large animal.

The call of this matured, captive elk seemed to express mild annoyance, as when approached too closely when not in the mood to be handled, or when some tidbit, such as a cigarette, of which he is very fond, was withheld from him unduly.

Adult cows reply to their offspring by a similar note, a stronger, more mature modification of the calf squeal, but in essentially the same form. When a calf has been disturbed and has wandered from its hiding place, I have heard the mother calling to attract the little one's attention and guide it to her.

A traveling band of cows and calves, in summer, may be traced in its course by the constant, noisy squealing. The cows and calves maintain a continuous communication in this manner, probably tending to keep the animals together, al-

though in rapid flight this is no doubt impossible. The process appears precisely comparable with the calling of ewes and lambs in a domestic sheep herd.

The clamor of traveling herds varies from an occasional call in a slowly moving group to a confusion of excited sounds from a herd fleeing from danger. In the latter case the greatest volume of calling occurs when the animals slow up after a preliminary burst of speed. In my field notes I find rapidly moving elk bands repeatedly described as accompanied by "squealing, barking, roaring and bugling, making a great racket."

The calf squeal appears to be a primitive sound, issuing from the throat with a minimum of modification by vocal organs. One could hardly attribute direct, intentional communication between individuals to this means, particularly when a calf squeals in pain or terror. Rather, it is more likely a spontaneous expression of feeling or emotion, which, however, may be correctly interpreted by other animals chancing to hear it. Moreover, other animals may respond to it in a definite way. We may conclude, for instance, that the calf call in its various forms indicates terror, anxiety (as when separated from the mother), vague desires (as perhaps when the calf seeks its mother for milk) and other more or less definite feelings, such as consciousness of proximity of calf with parent, and other minor acknowledgments of attention from one to another which elicit low, intimate vocal expressions. Companions hearing these various sounds appear to understand the emotion involved, without conscious effort having been used to convey these impressions. However, in some cases, when for example the mother calls to the calf to guide him to her, one can not escape the thought that after all there may be a rudimentary form of direct, conscious effort to convey an idea to another individual.

THE ALARM CALL

When alarmed or suspicious of lurking danger a more definite call is used: a sharp, startling bark, "Eeough!", with a little hint of the squeal mingled with the loud, hoarse bark. This call is used by all elk over one year old, male or female.

The occasion for this call, as I have noted it, is always alarm and suspicion, or possibly a state of excitement and confusion. While it serves as a warning to other members of the herd, I am convinced that there is no precise, conscious desire to convey to others such an idea by the elk who gives the alarm. Rather I believe this to be a spontaneous outburst expressing the emotion of the animal. Just as human beings are able to correctly interpret a cry of pain from an animal without the aid of organized speech, the other elk instinctively recognize the emotion involved and become alert to detect the danger.

An incident experienced in June, 1932, will illustrate the process. I had come out on top of a high hill and looking down in the valley on the other side, I spied a small herd of elk, chiefly cows and calves.

They were peacefully grazing in a small open meadow, the calves nosing about their mothers or frisking about in casual play. Suddenly one of the cows came to "attention" and uttered a sharp bark of alarm, meantime gazing steadily down the valley. All the others froze into alert attitudes, searching the surroundings for the source of the alarm. After a time the bark was repeated. The others turned their heads this way and that, searching in all directions. The calves

sensed the feeling, crowded around the cows and looked about, apparently not comprehending fully what it was all about. From time to time some of the animals shifted their positions and some were inclined to begin grazing. However, even though the danger had not materialized, so far as I could discover, the tension was too great, the band gave way to their fears and fled.

Another instance is also typical. In an aspen grove, late in May, I came on a lone cow elk and I suspected an elk calf was in the vicinity. Creeping up close to the cow I watched her feeding for a long time, until my patience gave out. Then, as an experiment, I gave the coyote howl. Up came her head and she stood still, apparently looking for the coyote, but in the opposite direction. Presently I howled again, at a distance of less than fifty yards. She came toward me at once and passed me on the run, having missed the exact direction of the sound. Presently she spied me. After a startled look she jumped away a short distance, barked, shifted about uneasily and continued barking.

It was clear that her calf was hidden somewhere in the vicinity, and a little later I found it, two hundred yards away. At the sound of the coyote call she had silently sought for the animal, as a potential danger to her calf, but evidently not a danger to herself. It was something which she felt she could cope with and she did not give the danger call. I have seen a cow elk silently attack a dog in the vicinity of her calf.

Upon seeing me, on the other hand, she recognized the human enemy, too powerful to attack or drive away and at once the bark of alarm signified her fear and concern for the safety of her calf, and her helplessness. There were no companions with whom to communicate and the call in this case was clearly an impulsive expression of emotion, directed, to be sure, toward the intruder.

Near my camp on the evening of August 16, 1928, several cow elk spied the tent and after barking a little disappeared into the woods. One cow continued barking at rather frequent intervals. Darkness came and still I heard the sounds coming from the woods and she kept this up for at least an hour and three quarters, until long after dark. This prolonged performance surely did not involve sudden fright or a continual warning to other elk. Rather, the animal seemed very much puzzled and curious, perhaps also sensing possible danger. Curiosity and fascination for the lighted tent could easily be controlling forces in such a case, comparable with the excited chatter of the red squirrel under certain conditions.

The danger call may be used at any time, at any season, although in the Jackson Hole country so many of the elk become semi-domesticated on various feed grounds that the call is not often heard in winter.

BUGLING

Under this head I have included several calls which have a general resemblance to each other and appear to have a common background. Bugling, proper, is generally understood to take place in the fall, during the rutting season and to be confined to the old bulls. However, this conception must be broadened in several respects.

One old timer informed me that he had heard bull elk bugling in practically every month of the year. When questioned, he admitted that in the spring he had only heard the sounds but had not actually seen the animals bugling, and had assumed that they were young bulls.

In Yellowstone Nature Notes for June, 1931, a note is published to the effect that bull elk bugle in the spring, but it is not clear whether the animals were actually seen.

Each spring I have heard considerable bugling in May and early June. A puzzling circumstance was the fact that these sounds were heard in places where cows and new-born calves were abundant and where bulls were scarce. Finally I was able to run down the calls and saw an adult cow raise her muzzle and give a long clear bugle call. Afterward I was able to make further observations confirming my conclusion that in the spring of the year, when the calves are dropped, the cows are bugling. On the other hand I have not actually seen bulls bugle in the spring, nor have I ever seen a young bull, such as a spike bull or a two-year-old, bugle at any time of the year, even in the rutting period. Much of the bugling at any season is heard without seeing the animal, and it would be possible that some of the calls heard in the spring came from bulls. I am confident, however, that it is normal for cows to bugle at this time of year.

It should be noted, however, that this spring bugling is by no means as loud and full-chested as the ringing calls heard among the rutting bulls in autumn, and it is natural that it should have been considered the efforts of young bulls.

On the evening of June 7, 1929, I found a cow elk giving voice to peculiar sounds, a "combination of squeal and groan, difficult to describe" as I have it in my note book. I watched her for a long time. She grazed along hurriedly, frequently voicing the peculiar, hoarse squeals. Sometimes the sound dropped to low, short whines. I suspected she was near parturition.

Another cow nearby spied me and became alarmed. The "noisy" cow stood for a long time at attention, looking for the danger. When she finally spied me she ran a distance, then began barking. She circled about and deliberately picked up my trail. She continued to act very much as if she had a calf nearby. Darkness came and I left her, still barking.

Interpretation of this incident and other "bugling" of cows will be deferred until after consideration of the calls of the rutting period.

The finest development of elk calls culminates in the bugling of the old bulls in the rutting time. The sound has been referred to as bugling, whistling, roaring, and many other terms. Indeed, the sound itself does vary greatly, justifying the variety of descriptive phrases found in literature. Sometimes the rutting bull does produce a roaring sound, as though his voice, wearied by frequent use, stuck on a low pitch and failed to rise to the high clear notes. At a little distance the sound reminds one of the hoarse bellowing of a domestic bull.

Normally, however, the call begins on a low note, slides upward until it reaches high, clear, bugle-like notes, which are prolonged, then drops quickly to a final grunt, the call frequently being followed by a series of grunts. The call may be very roughly represented thus: "A-a-a-a-ai-e-eeeeeeee-eough! e-uh! e-uh! e-uh! e-uh!" At close range the low notes are clearly heard: a reedy quality is heard, changing rapidly as the high note is struck, almost organ-like; a deep resonance from the capacious chest accompanies it all. At a distance the low, hoarse notes are lost to the ear, to a great extent, and the high bugle notes are especially clear, giving rise to the impression of "whistling."

There is much variation in pitch and character of the bugling of different in-

dividuals, especially noticeable when three or four bulls in the same vicinity are heard in close succession.

At the height of the rutting season one can often hear other sounds, sometimes only the series of grunts, "Euh! Euh! Euh!," without the bugling, or another series of peculiar sounds heard more rarely. These notes at a distance give the impression of a "tapping" like the tapping of a drum stick on wooden blocks. This I found was a sharp coughing sound, with a liquid quality, as if a container filled with water were struck, "Uh! Uh! Uh!".

I have heard bull elk bugling as early as August 21 and bugling lasts until the latter part of October at least. However, the bugling in August is very intermittent and not usually associated with active pursuit of cows. Even early in September the bugling lacks the fervor and heat which develops later in the month.

In general literature much is made of the idea of rivalry and direct challenge in the bugling of the elk. It is, of course, extremely difficult to determine mental activity of animals. From close observation of rutting bulls however, and study of circumstances, I am convinced that there is no direct challenge, as such, in the elk bugle. True, the master of a harem of cows will give voice to the finest, loudest call within the power of his great chest and lungs. A real rival, lingering on the outskirts of the band, will reply in kind, and back and forth the vocal battle is waged. However, early in the season, bulls begin their bugling in the presence of male companions often with no sign of ill feeling among them. At a later date, if there is no rival present, the bull bugles just as energetically and regularly. A wandering, unattached bull bugles at intervals even though he is not conscious of the presence of other bulls.

Close watching of bugling bulls reveals that they are in a turmoil of unrest. The physiological development at this period has produced a greatly swollen neck and other sexual changes have taken place. The tremendous sexual urge and intense emotional state of the animal require definite expression. The elk cows are very evasive. The bulls are under terrific strain and the bugling appears to be but a partial outlet for their pent-up feelings. Among birds the males often give voice to song in the mating period. The bugling of the elk may be, after a fashion, comparable to bird song as a natural expression of emotion.

It is true, there is rivalry among bulls and definite attempts at intimidation. However, I have never seen the slightest indication that an intruder has been frightened off by a rival's bugling, but the slightest offensive gesture on the part of the herd master, such as a charge in the direction of the intruder, *does* have an immediate effect.

Referring, now, to the bugling of the cows in spring, we note that this takes place during the general period of parturition. An instance has already been cited showing that a cow elk which had probably recently given birth to a calf or was about to do so, gave voice to her feelings with peculiar calls. The bugling of cows at this time involves no rivalry and the conclusion seems inevitable that their calls are an expression of feelings derived in some way from the important sexual development attending the near approach of parturition. The bugling of cows is but an echo of the powerful call of the rutting bull, but appears to be of the same pattern and I am convinced that it in turn is connected with the reproductive process.

SUMMARY

Elk calves give voice to a squealing call, to which the mother replies in a deeper voice. Adult elk express alarm, concern, or curiosity by a sharp bark. Adult bulls in the rutting season, and cows in the spring during the period of parturition, give emotional expression by bugling, most highly specialized in the bulls. Elk calls, for the most part, are an expression of individual feeling and do not appear to be in the nature of direct, conscious communication.

U. S. Biological Survey, Jackson, Wyoming.

TRAPPING ANIMALS ALIVE

By Vernon Bailey

Trapping animals for study and for specimens has been for over fifty years an important part of my work, and in the collecting of thousands of large and small mammals I have tried most of the traps in common use. Most of the small mammals can be taken in traps that kill them quickly, without pain or mutilation, but the same types of traps can not safely or successfully be used for larger animals. They would be too large to be conveniently carried and would be dangerous for domestic animals and even for humans. A trap of the out-of-sight type large enough for a wolf would kill a dog or a man.

For capturing small mammals alive for study of habits I have devised many simple types of traps, making them from tin cans, bottles, jars, boxes, bowls, and wire mesh. Glass jars sunk in the ground are excellent traps for some burrowing species. Any of the smaller mammals except bats can be taken in some kind of a trap, and bats can be caught with nets or picked from the walls of caves or old buildings.

Twelve years ago, at the first annual meeting of the American Society of Mammalogists, I read a paper on capturing small mammals alive, and since that time I have given much thought to methods of taking larger animals alive without injury or unnecessary discomfort. Now I can offer devices by which almost any land mammal, of any size, can be taken successfully without using the ordinary steel traps.

Capture of such of the larger carnivores as are a menace to game, poultry, and livestock, and of the fur-bearers has presented the most difficult problems, and up to the present time has seemed to demand the use of steel traps. Much as we all object to the suffering inflicted upon these animals by the ordinary steel trap there seemed no escape from it, for there has been no effective substitute that would take the animals without pain or mutilation. To find such a substitute has been my aim, and the problem now seems on the way to being fully solved.

Because of the present low prices of furs there is little interest in fur-trapping, and it is to be hoped that our rarer fur-bearers may be able to increase before the prices on their pelts become high enough again to threaten their existence. The control of a few of the larger

predatory species, however, is of importance in many sections of the country, and simple, inexpensive, humane traps will remove many of the objections to past methods, and will help to solve the problems of control. The advantage of these traps is that any animal caught by mistake can be released without injury or harm.

Selecting from the many kinds of live-traps tested, I presented before the American Society of Mammalogists at its recent meeting three types of cage traps—one for beavers, one for muskrats, and one for cats—all well tested and all now coming into common use. Also two types of chain traps were shown that are being tested and that promise to be useful in taking carnivorous and fur-bearing mammals of all sizes; also one for taking hawks and owls and other large birds.

The beaver trap was described and illustrated in 1927 in Technical Bulletin No. 21 of the United States Department of Agriculture, but since then it has been improved in many ways. Various state game and conservation departments and numerous individuals interested in removing beavers from cultivated to uncultivated land, or in management of the animals on their own land, are now using this trap. Pennsylvania has led the way in beaver managment by taking many of the animals for distribution and selection for breeding stock. The beaver trap can be used for otters or other fur bearers of approximately the same size, but much simpler and less expensive traps are available for smaller snimals.

A very successful type of trap devised for taking muskrats alive is now in use in many localities. It is so simple that it is not considered patentable by the U. S. Patent Office and can be made by anyone with a trapping sense and a turn for mechanics. It consists of a woven wire basket top attached to a sheet metal base and provided with a coiled spring so arranged that when a trigger is touched the basket comes over and encloses the muskrat. The trap can be set in shallow water, at the entrance of burrows, across runways on the marshes, or on floating planks.

A cat trap is easily made of a strip of one-inch mesh chicken wire, rolled into a cylinder and then pinched into a quadrangle one foot square and three feet long, one end closed with a square of the same mesh and the other end provided with a metal drop door hinged at the top to close the opening. A stiff wire attached to the lower edge of the door and passed through one of the open spaces on top of the trap has a sharp double bend near the upper end that engages in the mesh and holds the door closed when it drops. A swinging hook in the top of

the trap to hold up the door has a loop in the end of a long arm with a strong black thread attached to the loop and passed out of the top, over the side, down and across through the trap eight inches from the back end and four inches above the floor. The far end of the thread should be tied to the side of the trap so that a slight pressure on the middle of the thread will pull the hook from under the edge of the door and let it drop behind the cat, which is then a prisoner.

A small bag of catnip placed under the bottom of the trap near the back end is a very successful bait, or the powdered catnip available in ten-cent packages at any drug store can be scattered in the back end of the trap and a very little may be placed outside, leading up to the open door. A few drops of catnip oil add effect to the dried mint.

The cat can be removed from the trap by holding the mouth of a gunny-sack over the front and opening the door. The cat will generally rush into the sack, which can be closed by twisting the end or tying up with a string. If undesirable, the cat can be placed, sack and all, in a tin can, an ounce of carbon bisulphide poured in the bottom of the can, and the cover put on good and tight. The liquid quickly evaporates, forming a heavy gas that produces insensibility, resulting in death. There is nothing painful or cruel about either the trap or the gas.

This trap has proved highly successful for reducing the surplus cat population in alleys and back yards as well as in taking the half-wild cats in the woods and fields. It is also useful in taking skunks, mink, weasels, and rats around poultry yards, game farms, and in capturing many of the smaller fur-bearing animals for breeding and domestication. It can be adjusted in size for anything from bobcats to weasels and mice.

The most interesting and most important traps, however, are the three types of chain traps that can be described only briefly within the scope of the present paper. They have some features in common, especially the soft, short-link chains, varying in size to hold the different animals, and so smooth and flexible as not to injure the captives. In fact, after the animal is caught the chain and attachment constitute the whole trap, as they come free from the base, which has served only to place the chain securely around the ankle of the animal. The size and strength of chain to be used for a particular animal or group of animals have been determined in only a few cases, but this feature will be tested as soon as possible for other species.

The single-chain trap, which I have called the *foot-snare trap*, consists of an open base with an oval wire frame, with four upright projections to hold the chain loop in place and direct its motion upward when

sprung, and a coiled spring with an arm to throw the chain upward and around the animal's ankle when the trigger is depressed. The chain is temporarily attached to the arm of the spring, which not only throws it up but draws the open loop together through a hollow cylinder or ring with a catch that prevents it from returning or slackening when once drawn up around the animal's leg or ankle. A coiled spring in the chain prevents a sudden jerk or jar that might injure the animal.

For an animal the size of a dog or wolf a small, twisted-link chain about three feet long and weighing about four or five ounces will be required. The base of the trap will weigh about half as much, and the materials will cost approximately twenty-five cents. For bears, a larger chain and base will be required; two pound or three pound chains would seem about right for small and large bears.

One advantage of these traps is the low cost and light weight. The greatest advantage, however, is the possibility of releasing undesired animals without injury, and of being able to capture and transfer animals from one area to another.

The next type of chain trap I have called the *foot-hold trap.* It is especially adapted to the smaller carnivores such as coyotes, cats, and others even smaller. I would not, however, recommend it for muskrats, woodchucks, rabbits, or such other animals as can better be taken in cage traps.

This trap consists of a spring-steel wire bow with a one-turn circular ring in the middle about 2 inches across, and a half inch loop at each end. Between these end loops a flexible chain with a simple running knot in the middle is attached with only a mild tension that draws the ends of the spring into less than a half-circle bow. A wire base is formed by bending a heavy, soft wire in circular form with four upright projections to hold the chain and two upward and outward diverging prongs over which the loops in the ends of the spring-steel bow are placed when the trap is set. The single knot in the middle of the chain is then opened and spread around the four uprights on the frame and the spring held together by a trigger device held down by the catch of the wire or metal pan. When the pan is pressed downward by the animal's foot, the spring is released and flies outward and upward, and the loop in the chain is drawn around the ankle and held at any tension required to prevent escape but not tight enough to injure the foot or cut off the circulation of the blood. The spring of the bow prevents any sudden jerk or jar from injuring the leg, yet holds it securely and comfortably. A short three-link chain and swivel attached to the central ring in the spring and

to a firm stake will keep the trapped animal from escaping. This trap has been tested only on cats and dogs.

The third type of chain trap, called the *painless pole-trap*, is intended to take the place of the steel traps now so generally used in capturing hawks and owls on top of posts or poles where these birds are in the habit of alighting.

This trap consists of a steel-spring wire bow with a small flexible chain as a bowstring. A circular one-turn ring is bent in the middle of the bow and small loops at each end. To these small loops are attached the ends of the chain. In setting the trap a simple running knot in the middle of the chain can be opened out into a wide loop as the ends of the spring are brought together. The chain and bow constitute the whole trap, and the base on which it is set consists of a metal or wooden top, on which a circular wire with four upright prongs is fastened to hold the chain loop in place, and an upright on which to attach the trap spring. This inverted L-shaped base is fastened on top of the post or pole; the central ring in the spring is hooked over the head of a screw or wide-headed nail on the back of the upright; and the end rings of the spring are brought in and downward and caught over two small wire staples or pins in the back of the upright near the top. This loosens the chain and the single knot can be opened full length. The loop thus formed can be arranged around the four uprights on top of the wire circle and around the central pan, which is bent down at the rear of the trap and caught behind or against the spring tips. A slight downward pressure on the trap pan loosens the spring tips, and as these fly upward and outward the chain loop is drawn up and around the legs of any bird alighting on the pan. The trap is then released from the upright and, fastened only by a string near the base of the post, it allows the captive to sit comfortably on the ground or fly back to the top of the pole as it chooses. The spring that holds the chain prevents any jerk or struggle from injuring the bird and still holds it securely.

The advantage of this trap is that all harmless and useful hawks and owls can be released, and the few bird hunters can be destroyed or have their talons clipped so they will have to hunt grasshoppers for food. Similar traps can be used to capture other large perching birds for banding and studying their future movements.

It will take some time to test and perfect all of these traps and to educate the people to use them, but when perfected and available, they should enable us to handle and protect our wild life with greater ease and efficiency and less waste than in the past. Greater skill and intelli-

gence will be required in the use of these traps, but the elimination of cruelty in trapping will tempt more people to take an interest in it, and to become proficient in its technique. If their simplicity and economy would merely make it possible to destroy our wild life more rapidly I should say nothing about them, but so far as they prove an aid to better wild-life management, preservation, and study, they should serve a useful purpose.

Bureau of Biological Survey, Washington, D. C.

THE ABANDONMENT AND REOCCUPATION OF POND SITES BY BEAVERS

By Edward R. Warren

[*Plate 16*]

The following account has been written to show how beavers may occupy, abandon, and reoccupy a certain location on a stream. The locality is on Monument Creek, El Paso County, Colorado, about 15 miles northwesterly from Colorado Springs. In October, 1914, I found a dam on this part of the stream, and photographed it, but have no special description of it in my notes. I do not appear to have seen any dam at this place in 1913 or 1915. In October, 1922, I began a survey of the creek, numbering the various dams from the north down, and called the dam I then found at this place "No. 12," a term used in the following description.

The location of the various dams and ponds was below a big bend in the creek. Two fences and an old road crossed the stream above this, and immediately below the south fence the creek flows nearly due east for more than two hundred feet, and then resumes a southerly course, becoming wide between banks, sometimes over a hundred feet, at a flood time. From the bend on October 26, 1922, it was about 500 feet down to the upper end of pond No. 12, and 600 feet to the dam. A short distance above the upper end of the pond the right bank turned westerly a brief space, and then swung southerly again. Dam No. 12 was quite crooked, 75 feet in length, 30 inches high at the face, and above it the water in the pond was 2 feet deep. This dam persisted through most of the winter, at least, of 1922–23. I did not visit the place again for some time.

September 30, 1925, I found a new dam below where No. 12 had been in 1922. This was 35 or 40 feet long, and made a pond over a hundred feet long. Fifty feet above the dam brush was in the water and piled against the right bank. I called this dam "12A." Later in the winter I discovered a partly washed-away dam some little distance above this. On June 29, 1926, this dam seemed to have been wholly washed away, and in No. 12A was a wide gap, and the pond practically drained. A

little fresh cutting was seen among the willows on the right bank, but none was there a month later.

On October 1, 1926 a new dam was being constructed close to the site of the old dam I had found in the winter. I called it the "1926 dam." The water was already backed up a couple of hundred feet, though the dam was only 24 inches high on the face, with water 18 inches deep above it—a good illustration of the low gradient of the stream. The dam began at the right bank and extended 36 feet across toward the left, and still lacked 22 feet of reaching its foot. This dam was unusually interesting because of the fact that the ends of the brush of which it was being constructed lay exposed on the sandbar below, and many of the branches still retained their leaves, which were waving above the dam. The stream bed being wide here, and the little water there was all flowing at the right side, much of the dam extended across the bare gravel or sand, and the beavers had as yet done nothing toward covering or weighting down the ends of the brush. The butt ends of this were all laid downstream. On this date there were no indications that No. 12A was occupied.

October 15 the new pond was 250 feet long. The dam was 50 feet long, having been extended 14 feet during the previous fortnight, though it was not much higher and water was flowing over it in various places. In fact the new part was not much more than a little brush laid along the line of the dam, and consisted mostly of small peeled twigs. The upper side of the dam seemed to be well plastered with mud, though the ends of the brush below were still uncovered.

I was unable to visit this place until April, 1927. I found that the 1926 dam had not been extended to the left bank, and did not hold much water. A wing thirty odd feet long had been built upstream 30 feet from the right end, and the only pond now existing was between this wing and the right bank. In October, 1927, the 1926 dam was broken and a ruin. Several later visits were made, the last in April, 1932, but there were never any indications that the beavers had returned.

An abundance of willows grew on the right bank of the stream, along practically the whole length of the part occupied by the various ponds, and for a few hundred feet below the site of the lowest of the dams. They also grew less profusely on the left bank, at the lower end of the territory. These willows would afford food for many beavers. It was from among them that the animals obtained the material for

UPPER.—THE 1926 DAM FROM BELOW, AND THE LEFT BANK, APRIL 22, 1927
MIDDLE.—THE DAM GOING TO RUIN. FROM BELOW ON THE LEFT BANK, OCTOBER 27, 1927
LOWER.—SITE OF DAM FROM BELOW, AND LEFT BANK, MAY 28, 1929. ALL SIGNS OF DAM GONE

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their dams, as well as their living. On my different visits I found their trails on the right bank, which they used in going to their cutting areas, and on which they dragged the willows to the water.

At the right bank, in pond No. 12A, and in the old pond above, were piles of brush against the bank. I examined these in the spring and summer of 1926 and found that in each case the pile protected the entrance to a burrow. One of these piles was six feet wide and high, and extended six feet out from the perpendicular part of the bank, which here was 8 feet high above water level. The entrance to the burrow was 3 feet in under the bottom of the brush, which was laid without any regularity, just helter-skelter.

The other brush pile was 9 feet across, 5 high, and extended 6 feet out from the bank. The burrow which it protected was 4½ feet below the top of the bank. The entrance to this was at the lower corner of the brush and ran up under the latter toward this hole. There was sufficient protection for the inhabitants in their goings and comings. The edge of the brush was some little distance from the water.

I also found in the right bank shallow burrows, I think the ends of longer ones whose outer portion had been destroyed by erosion of the bank, for the banks of this stream are much exposed to such action.

Brush was also stored in the ponds at times, probably for winter use, for I found No. 12A frozen hard in December.

When I visited the stream April 20, 1932, I found another example of the beavers returning to the same location after leaving it. The winter of 1925–26 there was a pond some little distance below No. 12. This was abandoned in the spring of 1926 and in none of the succeeding years was the place reoccupied. In 1932, however, I found a fine dam, 100 feet long, and a pond 225 feet long. The dam was probably constructed in the autumn of 1931, and was about 50 feet below the site of the first one.

SUMMARY

1. A dam was first seen at the above described place (No. 12) in October, 1914.

2. The next dam was seen in 1922, the place not having been visited in the interval.

3. A pond was at the location the winter of 1925–26, and the dam was broken the spring of 1926.

4. The autumn of 1926 found a new dam and pond at the site.

5. Since the spring of 1927 the place has been unoccupied, though there is still plenty of food available for beavers.

6. The preceding account shows that beavers may occupy, abandon, and reoccupy a site at varying intervals.

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THE BATS OF THE GENUS EUMOPS

By Colin Campbell Sanborn

Since the founding of the genus *Eumops* no comparative review of its members has been published. This makes the identification of the various species difficult, and it is with the hope of partly clearing up this condition that this paper is written. Many of the species are but poorly represented in collections in the United States, and four recently described, known only from types in the British Museum, have not been available, so that a monographic revision of the genus is not now possible.

Representatives of the genus are known to occur throughout South America with the exception of Chile and French Guiana, and it will be found, no doubt, in the latter country. The genus occurs also in Panama, Cuba, and Jamaica, and in the United States in California and Arizona. There are two records from Mexico; but there are good reasons for doubting these, though the genus must be represented in that country. From recorded collections the genus appears to be uncommon in every part of its range.

The habits of the North American species, *Eumops californicus*, have been carefully studied by A. B. Howell and Luther Little, and recorded in the Journal of Mammalogy, vol. 1, pp. 111–117; vol. 5, pp. 261–263. The same general habits will undoubtedly be found in the South American forms, especially in *E. perotis*. Collectors' notes on labels say: "Caught in house." "Caught under roof of house." "Under galvanized roof." "In hollow dagame tree." A specimen of *E. bonariensis* from Uruguay was found hanging in a barn. The only breeding note is from a Peruvian specimen of *E. abrasus milleri* which on September 9 contained one embryo.

In some of its characters the genus *Eumops* appears to be a connecting link or transitional genus between certain other genera of the family *Molossidae*. The third upper molar in the genera *Tadarida*, *Chaerephon*. *Mormopterus*, and *Platymops* has a third commissure and a metacone. while in *Molossus*, *Promops*, *Eumops*, and *Cheiromeles* the third commissure and metacone are either absent or very minute. In *Eumops* the structure of this tooth shows all the stages found in the other genera

of the family. The variable shape of the tragus, which is very small and pointed, or broad and flat, might also be considered a transitional character. In a genus of this kind it is not surprising that we find two aberrant species. In one, the minute upper premolar is lacking, and in the other the lower incisors are not crowded, while in both the palate is extended well back beyond the level of the last molars.

This review is based on the examination of 185 specimens, 79 skins with skulls, 88 alcoholics with 11 skulls cleaned, 11 skulls only, and 7 skins only. I wish to thank Gerrit S. Miller, Jr., Curator of Mammals, United States National Museum, Washington, D. C., H. E. Anthony, Curator of Mammals, American Museum of Natural History, New York; Dr. G. M. Allen, Curator of Mammals, Museum of Comparative Zoology, Cambridge, Massachusetts; and Dr. A. Avinoff, Director of the Carnegie Museum, Pittsburgh, Pennsylvania, for the loan of material under their care.

Material from the foregoing collections and from the Field Museum of Natural History will be indicated by the following abbreviations: A. M. N. H.; U. S. N. M.; M. C. Z.; C. M.; and F. M. N. H.

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Genus **EUMOPS** Miller

Eumops Miller, Proc. Biol. Soc. Washington, Vol. 19, p. 85, 1906.

Type, *Molossus californicus* Merriam.

Dental formula: $i\ \frac{1-1}{2-2}$, $c\ \frac{1-1}{1-1}$, $pm\ \frac{2-2}{2-2}$ or $\frac{1-1}{2-2}$, $m\ \frac{3-3}{3-3} = 28$ or 30.

Size variable, very small or very large; tail extending well beyond interfemoral membrane; feet heavy; wings normal; ears very large and joined at base on forehead; antitragus large, tragus reduced, squarish or almost pointedly rounded. Male with gular sac. Skull solidly built but slender, with or without sagittal crest; lambdoid crest well developed. Basisphenoid pits fairly well developed. Third upper molar with or without third commissure and metacone. Small upper premolar well formed and present in all but one species. Lower incisors more or less crowded. Palate ending on level with last molars except in two species.

SYNOPSIS OF SPECIES

Premolars $\frac{1-1}{2-2}$ ..... *maurus*

Premolars $\frac{2-2}{2-2}$

Forearm 55–80 mm.

Forearm 74–80 mm.

California and Arizona ..... *perotis californicus*

South America ..... *perotis perotis*

Heavier skull, Chaco, Argentina ..... *perotis dabbenei*

Smaller teeth, Para, Brazil ..... *perotis trumbulli*

Forearm 55–65 mm.
Slight lachrymal ridge, lambdoid crest projected over supraoccipital, tragus small and pointed.
Eastern Brazil.....*abrasus abrasus*
Peru, No. South America and Panama.....*abrasus milleri*
No lachrymal ridge, supraoccipital extending beyond lambdoid crest, tragus well developed, quadrate. Northwestern South America and West Indies.....*glaucinus*
Forearm 38–49 mm.; M^3 with well developed third commissure and metacone.
Palate extended beyond level of last molar (greatest length of skull, 20.9 mm.); Brazil.....*hansae* sp. nov.
Palate not extended beyond level of last molar.
Greatest length of skull about 20 mm.; Buenos Aires and Uruguay *bonariensis bonariensis*
Greatest length of skull less than 18.5 mm.
Greatest length of skull about 18.2 mm.; North Brazil *bonariensis delticus*
Greatest length of skull, 16.4 to 17.8 mm.
Greatest length of skull, 16.4 mm.; Panama *bonariensis nanus*
Greatest length of skull, 16.9 to 17.8 mm.
Greatest length of skull about 17 mm.; Chubut, Argentina.....*bonariensis patagonicus*
Greatest length of skull, 16.9 to 17.8 mm.; Paraguay and Bolivia.....*bonariensis beckeri* subsp. nov.

Eumops perotis perotis (Schinz)

Molossus perotis "Maxmillian," Schinz, Das Thierreich, vol. 1, p. 870, 1821.
Dysopes perotis Wied, Abbild. z. Naturg. Bras., pl. and text, 1824; Beitr. Naturg. Bras., vol. 2, pp. 227–231, 1827.
P[romops] perotis Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 191, 1901.
E [umops] perotis Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85 1906.
Dysopes (Molossus) gigas Peters, Monatsber. Akad. Berlin, p. 381, 1864—Cuba.

Type locality.—Villa San Salvador, Campos des Goaytocasas, Rio Parahyba, Brazil.

Distribution.—South America east of the Andes, south of the Amazon, and north of the Parana River; Cuba.

Characters.—The largest South American species; forearm, 74–80 mm. Tragus large, almost square. Skull large, no lachrymal ridge; m^3 with well indicated beginning of third commissure.

Measurements.—Forearm, 74–80 mm. Skull: Greatest length, 30.4–32.9 mm.; condylobasal length, 29.1–31.8; zygomatic breadth, 17.5–19.8; interorbital breadth, 5.4–5.7; toothrow, 12.6–13.6; breadth across m^2, 12–13.2; rostrum, between points of lachrymal processes, 10–11.4.

Specimens examined.—25. Brazil: Villa San Salvador, Rio Parahyba (type), 1 (A.M.N.H.); Rio das Velhas, 3 (M. C. Z.); Lagoa Santa, 14 (F. M. N. H.); Barro do Corda, Maranhao, 5 (F. M. N. H.). Argentina: Tucuman, 1 (F. M. N. H.). Peru: Loreto, 1 (F. M. N. H.). Paraguay: Asuncion, 2 (F. M. N. H.).

Remarks.—Specimens of *Eumops perotis* from different parts of its range show some slight variations but material now available is not sufficient to characterize local subspecies.

Eumops perotis dabbenei Thomas

Eumops dabbenei Thomas, Ann. Mag. Nat. Hist., ser. 8, vol. 13, p. 481, 1914.

Type locality and distribution.—Territory Chaco, Argentina.

Characters.—Described by Thomas from two specimens as being larger with a "much broader and more heavily made skull" than *perotis*.

Measurements.—From the original description: "Dimensions of male and female specimens (the latter the type):—Forearm, 82 and 79 mm. Head and body, 115, 106 mm.; tail, 61, 59; ear (perhaps shrunk), 28, 27 mm.; third finger, metacarpal, 83, 77, first phalanx, 37, 33; lower leg and hind foot (c.u.), 45, 41.

Skull: Greatest length, 33.5, 31 mm.; condyloincisive length, 32.3, 30.7; condylobasal length, 31.5, 29.4; zygomatic breadth, 20.4, 29.4; intertemporal breadth, 6.1, 5.7; mastoid breadth, 17.5, 16.3; palatal length, 14, 14.2; maxillary toothrow, 13.7, 13.2; front of p^4 to back of m^3, 8.7, 8.6; breadth between outer corners of m^3, 14.2, 13.4."

Specimens examined.—None.

Remarks.—A skull from Barro do Cordo, Maranhao, Brazil approximates in size the two skulls of *dabbenei*. The zygomatic and mastoid breadths are less but the condylobasal length is greater. The other measurements, including the forearm, are intermediate. Thomas gives the zygomatic breadth of his specimens as 20.4 and 29.4 mm.; the latter figure appears to be a typographical error. The statements "mesial creast well developed" and "well marked occipital helmet" show the specimens to be very old, and this, I believe, accounts for their large size. Specimens from Paraguay and Tucuman are not so large. A topotypical series is needed before the validity of the supposed subspecies can be definitely established.

Eumops perotis trumbulli (Thomas)

Promops trumbulli Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 7, pp. 190–191, 1901.
E[umops] trumbulli Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.

Type locality and distribution.—Para, Brazil.

Characters.—This form was described, from one specimen, as being like *perotis* but smaller and with a skull of "generally lighter build."

Measurements.—Forearm, 75. mm.

Specimens examined.—None.

Remarks.—In the original description of *Promops trumbulli* Thomas speaks of the lighter build of the skull and says, "this may be partly due to immaturity." In another place he says, "epiphyses not yet fully united" so he must have had a young specimen. A skull taken from an immature specimen in alcohol from the Alto Rio Nanay, Loreto, Peru, agrees with the description of *trumbulli*, its teeth being equal to that species or slightly smaller. The notch at the center of the inner basal cingulum of the upper canine is also present. The forearm measures 66 mm.

Eumops perotis trumbulli was based on a young individual and more material is needed to prove its claim to subspecific rank.

Eumops perotis californicus (Merriam)

Molossus californicus Merriam, North Amer. Fauna, no. 4, p. 31. 1890.
Promops perotis californicus H. Allen, Bull. U. S. Nat. Mus., no. 43, p. 175, 1893.
Promops californicus Miller and Rehn, Proc. Boston Soc. Nat. Hist., vol. 30, p. 271, 1902.
Eumops californicus Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.

Type locality.—Alhambra, Los Angeles County, California.

Distribution.—Southern California and parts of Arizona.

Characters.—Externally similar to true *perotis*. The skull is much less robust in appearance, being narrower across the rostrum and having the anterior part of the braincase less swollen. The greatest difference lies in the width of the rostrum between the lachrymal processes, which in *californicus* is 10.1 mm. or less, while in *perotis* it ranges from 10 to 11.4 mm. The teeth also are very slightly smaller.

Measurements.—Forearm, 73–77.8 mm. Skull: Greatest length, 30.3–32 mm.; condylobasal length, 30–31.3; zygomatic breadth, 17.2–18.6; interorbital breadth, 5–5.3; upper toothrow, 11.9–12.6; breadth of rostrum between points of lachrymal processes, 9.9–10.1.

Specimens examined.—33. CALIFORNIA: Los Angeles, 21 (U. S. N. M.); Haywards, 1 (U. S. N. M.); Alhambra, 1 (U. S. N. M.); Colorado Desert, 1 (U. S. N. M.); Covina, 6 (U. S. N. M., 1; F. M. N. H., 4; A. M. N. H., 1); Azusa, 1 (A. M. N. H.). ARIZONA: Tempe, 1 (U. S. N. M.); Parker, 1 (U. S. N. M.).

Remarks.—I wish to thank Luther Little, who sent me the measurements of seven of his largest skulls. Skins with skulls are scarce in eastern museum collections.

Eumops abrasus abrasus (Temminck)

Dysopes abrasus Temminck, Monogr. Mamm., vol. 1, pp. 232–233, pl. 21, 1827; vol. 2, p. 356, 1835–41.
Molossus abrasus Peters, Monatsber. Akad. Berlin, p. 574, 1865.
M[olossus] (Promops) abrasus Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 141, 1901.
Promops abrasus Miller and Rehn, Proc. Boston Soc. Nat. Hist., vol. 30, p. 271, 1902.
E[umops] abrasus Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.

Type locality.—Interior of Brazil.

Distribution.—Eastern Brazil.

Characters.—Forearm 62.3–63 mm. Color reddish brown. Length of tibia, 20 mm. or less. Tragus very small, proportionately smaller than in any other species. Skull with slight lachrymal ridge, and well developed lambdoid crests that are projected beyond supraoccipital. The indication of the third commissure on molar three is less developed in *abrasus* than in the other species. Even at its greatest development, the posterior half of the outer edge of the tooth is shorter than in the most nearly related species, *Eumops glaucinus*.

Measurements.—Forearm, 62.3–63 mm. Skull: Greatest length, 24.9–25.7; condylobasal length, 23.2–23.8; zygomatic breadth, 14.9–15.3; interorbital breadth, 4.9–5.4 mm.; braincase, 11.4; upper toothrow, 10–10.6; breadth across canines, 6.3–6.6; breadth across m^2, 9.8–9.9.

Specimens examined.—4. BRAZIL: Quixada, Ceara, 3 (F. M. N. H.); Furnas do Yporanga, São Paulo, 1 (M. C. Z.)

Remarks.—Typical *Eumops abrasus* from Brazil is rare in collections in this country. It appears to be confined to eastern Brazil and has been rarely taken.

Eumops abrasus milleri (Allen)

Promops milleri Allen, Bull. Amer. Mus. Nat. Hist., vol. 13, p. 92, 1900.
E[umops] milleri Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.
Promops barbatus Allen, Bull. Amer. Mus. Nat. Hist., vol. 20, p. 228, 1904—La Union, Venezuela.
E[umops] barbatus Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.
Eumops glaucinus Miller, Proc. U. S. Nat. Mus., vol. 42, p. 26, 1912; Goldman, Smithson. Misc. Coll., vol. 69, p. 219, 1920.

Type locality.—Guayamba Peru.

Distribution.—Peru, and from the southern border of the Amazon north into Panama.

Characters.—Like typical *abrasus*, but averaging smaller throughout. Condylo-basal length of skull, 23 mm. or less.

Measurements.—Forearm, 56–63 mm.; tibia, 16–19.5. Skull: Greatest length, 23–25.1 mm.; condylobasal length, 21–23; palatal length, 13.5–15.1; interorbital breadth, 4.4–4.9; braincase, 9.8–11.6; upper toothrow, 9.4–10.6; breadth across canines, 5.7–6.7; breadth across m^2, 9.2–10.

Specimens examined.—69. PERU: Guayamba, 4 (A. M. N. H.); Vista Alegre, 2 (F. M. N. H.); Hacienda San Antonio, Rio Chinchao, 2 (F. M. N. H.); Colonia del Pereni, 6 (U. S. N. M.). BRAZIL: Para, 2 (M. C. Z.); Lake Hyanuary, 1 (M. C. Z.); probably Brazil, 1 (M. C. Z.). COLOMBIA: Baracoas, 8 (A. M. N. H.); Honda, 1 (A. M. N. H.); Don Diego, Santa Marta, 12 (C. M.). VENEZUELA: La Union, 1 (A. M. N. H.); Eldorado, Rio Cuyuni, 11 (A. M. N. H.); San Fernando, 2 (A. M. N. H.). BRITISH GUIANA: Cartabo, 1 (A. M. N. H.). DUTCH GUIANA: 1 (U. S. N. M.). PANAMA: Paraiso, 1 (U. S. N. M.); Bohio, 12 (U S. N. M.). BOLIVIA: Ixiamas, 1 (U. S. N. M.).

Remarks.—The majority of the specimens of *Eumops abrasus milleri* are smaller than any of the specimens of true *abrasus*. In one from Venezuela the skull is almost the same size as one from Ceara, but it has a small forearm, while in one from Peru the forearm is long enough for *E. abrasus abrasus* but the skull is too small. A large series of *abrasus* from Brazil, especially from inland localities, may show *milleri* to be synonymous with it.

Eumops maurus (Thomas)

Molossus maurus Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 141, 1901.
Myopterus maurus Trouessart, Cat. Mamm., Suppl., p. 101, 1904.
E [umops] maurus Miller, Proc. Biol. Soc. Washington vol. 19, p. 85, 1906.

Type locality and distribution.—Kanuku Mountains, British Guiana.

Characters.—Described as being like *Eumops abrasus* externally. Skull also similar but with the palate extending one millimeter beyond the level of the last molar. In the only specimen known there is no trace of the minute upper premolar. Forearm, 53 mm.

Measurements.—From original description: Forearm, 53 mm.; head and body, 64 mm., tail, 51, ear, 19; antitragus, 6.1 x 4.5; third finger, metacarpal, 53, first phalanx, 24.5, second phalanx, 22.5; tip of knee to tip of hind claw, 29.

Specimens examined.—None.

Remarks.—*Eumops maurus* appears to be an aberrant species, as is also *E. hansae* from Brazil, in which the palate is likewise extended beyond the last molar.

Eumops glaucinus (Wagner)

Dysopes glaucinus Wagner, Weigmann's Archiv. f. Naturg., p. 368, 1843.
Molossus glaucinus Dobson, Proc. Zool. Soc. London, p. 714, 1876.
Promops glaucinus Miller, Ann. Mag. Nat. Hist., ser. 7, vol. 6, p. 471, 1900.
E[umops] glaucinus Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.
Molossus ferox Gundlach, Monatsber. Akad. Berlin, p. 149, 1861—Cuba.
Nyctinomus orthotis H. Allen, Proc. Amer. Phil. Soc., vol. 26, p. 561, 1889—Spanishtown, Jamaica.
Promops orthotis Miller, Proc. Biol. Soc. Washington, vol. 15. p. 250, 1902.
E[umops] orthotis Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.
Tadarida orthotis Miller, Bull. U. S. Nat. Mus., No. 128, p. 87, 1924 (by lapsus).

Type locality.—Cuyaba, Matto Grosso, Brazil.

Distribution.—Colombia and Ecuador in South America, and Cuba and Jamaica in the West Indies.

Characters.—About the size of *Eumops abrasus* with which it has often been confused. It differs externally in the shape of the tragus, which is well developed, broad, and square across the top. The tibia measures over 20 mm. while in *E. abrasus* it is usually less. In the skull the supraoccipital extends beyond the low lambdoid crest, and there are no lachrymal ridges. The third commissure on m^3 is also more developed than in *abrasus*.

Measurements.—Forearm, 58–61 mm.; tibia, 20.5–22. Skull: Greatest length, 22.4–24.3 mm.; condylobasal length, 21.5–23.3; zygomatic breadth, 13.9–15.4; interorbital breadth, 4.8–5.2; braincase, 11.4–11.9; toothrow, 9.5–10.3; breadth across canines, 5.7–6.3; breadth across m^3, 9.6–10.2.

Specimens examined.—22. Colombia: Honda, 5 (A. M. N. H.); Santa Marta, 2 (A. M. N. H.). Ecuador: Guayaquil, 3 (U. S. N. M.). Cuba: Madruga, 1 (M. C. Z.); Cobre, 2 (A. M. N. H.); Pinar del Rio, 1 (U. S. N. M.); Guantanamo, 1 (U. S. N. M.). Jamaica: Spanishtown, 2 (U. S. N. M.); St. Andrews, 3 (U. S. N. M.). Mexico: Morelos, 1 (U. S. N. M.); Yucatan, 1 (U. S. N. M.).

Remarks.—Comparison of the type of *Nyctinomus orthotis* H. Allen with this series shows no characters to distinguish it from *Eumops glaucinus*. At the time Allen described *orthotis* he had never seen *glaucinus*, as his remarks in his monograph of 1893 (p. 175) show. Dobson lists a specimen from Bolivia and includes Surinam in the range. The present known distribution seems to cast some doubt on the correctness of the recorded type locality, especially as the five recent expeditions to Matto Grosso have failed to find this species.

Eumops bonariensis (Peters)

(Synonymy under subspecies)

Distribution.—From Panama to Patagonia in South America, with the exception of all the west coast.

Characters.—The smallest species in the genus; forearm, 38–49 mm. Upperparts from reddish to blackish-brown, flecked with scattered gray hairs. Underparts drab to gray. In general the skull is similar to that of *Eumops glaucinus*, but the lambdoid and sagittal crests are less developed and it is relatively broader across the rostrum. In *E. glaucinus* m^3 has but a slight indication of a third commissure, while in *E. bonariensis* it is well developed.

Remarks.—Since Peters' description of the type in 1874 no record of other specimens from near the type locality, Buenos Aires, has been published, with the exception of one from Uruguay. Published records of *bonariensis* refer to specimens from Bolivia, Paraguay, and Goya, Argentina, all a long distance from the type locality. Peters' type is intermediate in size between the northern series and the specimen from Uruguay, but as the Uruguayan specimen is from nearer the type locality and agrees more closely with the original description in color and in the shape of the skull, it has been taken to represent typical *bonariensis*. Thomas described from single specimens two forms related to *bonariensis*, but what he regarded as typical *bonariensis* is not clear.

Eumops bonariensis bonariensis (Peters)

Promops bonariensis Peters, Monatsber. Akad. Berlin, pp. 232–234, 1 pl. with figs. 1–10, 1874.

Molossus bonariensis Dobson, Proc. Zool. Soc. London, p. 715, 1876.

E [umops] bonariensis Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.

Type locality.—Buenos Aires, Argentina.

Distribution.—Known only from the type locality, and from Treinte y Tres, Uruguay.

Characters.—The largest of the *bonariensis* group; forearm, 45–49 mm.; skull, 18.6–20.1 mm. Color above, dull reddish brown, below, grayish brown, all the hairs with pale bases. The third commissure on m^3 well developed.

Measurements.—Total length, 130 mm.; tail, 48; foot, 12.5; forearm, 49. Skull: Greatest length, 20.1; condylobasal length, 19.3; zygomatic breadth, 12.4; interorbital breadth, 4.6; braincase, 9.7; toothrow, 8.1; breadth across canines, 5.1; breadth across m^3, 7.6.

Specimens examined.—URUGUAY: Treinte y Tres, near town of Treinte y Tres, 1 (F. M. N. H.).

Remarks.—The lack of material from the type region has caused specimens from Paraguay and Bolivia to be identified as true *bonariensis*, when in fact they are much smaller and of a different color. For these specimens I propose the name

Eumops bonariensis beckeri subsp. nov.

Molossus bonariensis Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 440, 1901.

Eumops bonariensis Osgood, Field Mus. Nat. Hist., Zool. Ser. vol. 10, p. 214, 1916.

Type from Trinidad, El Beni, Bolivia. No 21536, Field Mus. of Nat. Hist. Adult male. Collected March 22, 1915, by R. H. Becker. Orig. no. 846.

Diagnosis.—Similar to *E. bonariensis bonariensis* but smaller and of a more grayish-brown and less reddish-brown color.

Color.—Upper parts of type close to bister of Ridgway (1912) with light gray hairs scattered throughout. Underparts wood brown on flanks and lower sides, dark gray on belly, and brownish on throat. The Trinidad series is in a changing pelage and in some the throat has many gray hairs and the flanks and sides are gray, due to the wearing of the wood brown tips to the hairs. In a series from Paraguay the throat is drab and the remaining underparts are between light drab and drab gray. The upperparts are darker, being almost mummy brown. In all the specimens there are light gray hairs scattered over the upperparts.

Skull.—Similar to that of *E. bonariensis bonariensis* but smaller throughout.

Distribution.—Bolivia; Paraguay; and Goya, Argentina.

Measurements.—Type (maximum and minimum of others in brackets): Forearm, 45.7 mm. (41.2–46.5). Skull: Greatest length, 17.8 mm. (16.9–17.8); condylobasal length, 16.9 (15.9–16.9); zygomatic breadth, 10.9 (10.4–11.5); braincase, 8.7 (8.7–9.3); upper toothrow, 7 (6.6–7.1).

Specimens examined.—31. Bolivia: Trinidad, 18 (F. M. N. H., 13; A. M. N. H., 4; M. C. Z., 1). Paraguay: Asuncion, 13 (U. S. N. M. 11; A. M. N. H., 2).

Eumops bonariensis delticus Thomas

Eumops delticus Thomas, Ann. Mag. Nat. Hist., ser. 9, vol. 12, p. 341, 1923.

Type locality.—Caldeirão, Marajo Island, Brazil.

Distribution.—Known definitely only from the type locality.

Characters.—Described, from one specimen, as being similar to typical *bonariensis*, but less gray below and with a larger canine that shuts off the minute premolar into angle between it and the larger premolar. Forearm, 47 mm.

Measurements.—From original description: Forearm, 47 mm.; head and body, 68 mm.; tail, 41; ear, 19. Third finger, metacarpal, 48 mm., first phalanx, 20. Skull: greatest length, 18.2; condyle to front of canine, 17.1; mastoid breadth, 10 mm.; intertemporal breadth, 4.1; front of canine to back of m^3, 7.2.

Specimens examined.—The following specimens fit the description of *E. b. delticus* so closely, especially in the measurements of the skull, that they are referred to it. Brazil: Bahia; Sao Marcello, 3 (F. M. N. H.).

Remarks.—While externally the type and the specimens now referred to *E. bonariensis delticus* are about the same size as true *bonariensis*, the skulls are smaller than either the specimen from Uruguay or Peters' type.

Eumops bonariensis patagonicus Thomas

Eumops patagonicus Thomas, Ann. Mag. Nat. Hist., ser. 9, vol. 13, p. 234, 1924.

Type locality.—Chubut, Argentina.

Characters.—Described, from one specimen, as a small species like *E. bonariensis* with a "large, smooth, globose braincase and short muzzle."

Measurements.—From original description: Forearm, 44 mm.; head and body, 54 mm.; tail, 31; ear, 14.5; across the two ears, 30; lower leg and hind foot (c.u.),

22. Skull: Greatest length, 17 mm.; condylobasal length, 15.8; mastoid breadth, 10; interorbital breadth, 4; front of canine to back of m^3, 15.8 (sic).

Specimens examined.—None.

Remarks.—From the measurements given in the description this form appears to be about the same size as *Eumops bonariensis beckeri* from Paraguay and Bolivia, and this has caused me to wonder if there could have been any mistake in the locality. It will be noted in the measurements that the toothrow is given as the same as the condylobasal length.

Eumops bonariensis nanus Miller

Promops nanus Miller, Ann. Mag. Nat. Hist., ser. 7, vol. 6, p. 470, 1900.

E[umops] nanus Miller, Proc. Biol. Soc. Washington, vol. 19, p. 85, 1906.

Type locality.—Bugaba, Chiriqui, Panama.

Distribution.—Panama.

Characters.—The smallest race of *Eumops* known. Dark bister above and broccoli-brown below.

Measurements.—Forearm, 39 mm. Greatest length of skull, 16.4 mm.

Specimens examined.—3. PANAMA: Bugaba, Chiriqui, 1 (U. S. N. M.); Boqueron, 2 (A. M. N. H.).

Remarks.—The development of the third commissure and metacone on m^3 shows this form to be closely related to *E. bonariensis*.

Eumops hansae sp. nov.

Type from Colonia Hansa, near Joinville, Santa Catherina, Brazil. No. 200,993 U. S. Nat. Mus. Adult male. Collected in 1901 by H. Ehrhardt. Original number, Museu Paulista, 1339.

Diagnosis.—Externally very similar to *E. bonariensis* but with a shorter forearm. The skull is slightly larger and has a longer palate; tips of upper incisors not in contact, and lower incisors not crowded.

Color.—Most of the hair is gone from the rump and from one side of the back, but the remaining hairs are very dark brown with gray bases. The underparts are lighter, the hairs being gray-brown with light colored bases.

Skull.—The skull is about the same shape as in *E. bonariensis*, but has a slightly longer and narrower rostrum. In structure it differs in various ways. The basisphenoid pits are deeper and rounder; the palate projects well back beyond the last molars, while in *E. bonariensis* it ends almost on a level with these teeth. The lambdoid crest is more developed. The upper incisors have their tips widely separated, being almost a millimeter apart. The lower incisors are not bunched but are in almost a straight line, the outer about half the size of the inner, and with the edge of the crown projecting over the anterior face of the inner incisor. This might be individual variation. The third commissure is more developed than in *E. bonariensis* or any in any other member of the genus.

Measurements.—Forearm, 41.7 mm. Skull: Greatest length, 20.9 mm.; condylobasal length, 20; palatal length, 18.5; zygomatic breadth, 12.8; interorbital breadth, 4.4; width of braincase, 9.3; width of rostrum, 7.4; upper toothrow, 8.1; width at base of lower incisors, 3.1; lower toothrow, 8.4.

Specimens examined.—One, the type.

Remarks.—In most of its characters *E. hansae* is a typical *Eumops*. In the position of the lower incisors and the well developed third commissure on m^3 it shows a strong resemblance to *Tadarida*. It differs from both genera in having the tips of the upper incisors widely separated and the palate extended. In this latter character, however, it agrees with *E. maurus*. In proportion to the length of its forearm, *E. hansae* has a larger skull than any other species. There is a large bare space and dark spot on the throat which appears to be a gular sac.

Field Museum of Natural History, Chicago, Illinois

TWO NEW MIOCENE ENTELODONTS

By Frederic B. Loomis

In North America the entelodonts suddenly appear at the beginning of the Oligocene as several large species of *Archaeotherium*. These are peculiar in that the feet are reduced to two functional digits with only small vestiges of lateral toes, the teeth are bunodont, the premolars being almost carnivorous, and the lower jaws and the jugal arch have peculiar tuberosities. Through the middle Oligocene they are fairly common, especially the small species, *A. mortoni*, and there has not been enough change in their characters to warrant the establishment of another genus. However in the upper Oligocene the group, especially among the larger types, begins to vary widely and several new genera are distinguished.

When the tuberosities on the lower jaws are extremely enlarged the animals were called by Cope, *Pelonax*; when the jugal process was extremely enlarged they were named by Troxell, *Megachoerus*; when the tuberosities were reduced, the anterior one entirely disappearing, Cope established the genus *Daeodon*. The first two of these are found in the *Protoceras* beds, the last in the John Day beds. There also occurs in the John Day beds a more typical entelodont, to which, because of its recurved canines, Troxell gave the name *Chaerodon*. Then there was also found a set of limb bones to which Cope gave the name *Boöchoerus*, which, when similar bones are found associated with the skull, will probably be assigned to one or the other above mentioned genera. By John Day times these animals had become very scarce, and the only[1] reported later representative of the group is the giant pig, which Peterson described under the name, *Dinohyus*, found in the Lower Harrison beds of Nebraska.

In 1931 the Amherst College expedition found two more representatives of the later phases of this group, one in the Lower Rosebud beds which approximate the John Day, and the other in the Lower Harrison beds contemporaneous with *Dinohyus*.

[1] A single tooth from New Jersey has been assigned to this group under the name *Ammodon*.

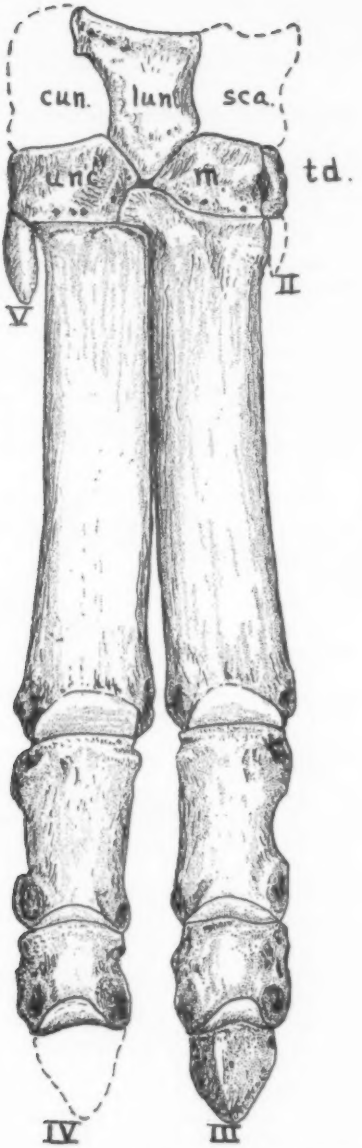

FIG. 1. BOÖCHOERUS ANGUSTUS, LEFT FRONT FOOT, ABOUT ⅔ NATURAL SIZE

Cun. cuneiform, *lun.* lunar, *m.* magnum, *sca.* scaphoid, *td.* trapezoid, *unc.* unciform.

Boöchoerus angustus new species

The type of this species consists of two almost complete front feet found on Porcupine Creek, South Dakota, in the Lower Rosebud. They are numbered 31–105 in the Amherst College Museum.

When this type is compared with Cope's *B. humerosus*,[2] it is evident that, though the arrangement of the bones is similar, we are dealing with an animal of very different proportions. In length the various metacarpals and phalanges are much the same, but those of *B. humerosus* are 50 per cent greater in width, so that, though a heavy beast, our animal is relatively slender.

In the carpus, the lunar wedges down between the unciform and the magnum until these two bones are entirely separated. This is in contrast to *Archaeotherium* where they have a considerable contact, but it approximates the conditions present in *Dinohyus* and *Boöchoerus*. In *Boöchoerus humerosus* the unciform and magnum are much more flattened than in *B. angustus*; so that on the whole the carpus of the latter resembles that of *Dinohyus*. The trapezoid, while small, is

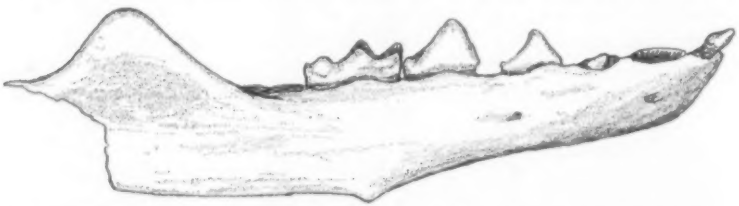

Fig. 2. Daeodon minor, the Right Lower Jaw with the Deciduous Premolars, About ⅓ Natural Size

present and has facets for a small metacarpus II, which is true also of *Dinohyus* and *Archaeotherium*. On the outside there is a vestige of metacarpus V as in all the group. In this species metacarpals III and IV are slenderer than in either *Dinohyus* or *Boöchoerus*, though not as slender as in *Archaeotherium*; and the same may be said of the individual phalanges. The ungual phalanx is very like that of *Dinohyus*.

Measurements

	mm.
Length of metacarpus III	194
Width of metacarpus III	45
Length of upper phalanx III	74
Width of upper phalanx III	45
Length of middle phalanx III	54
Width of middle phalanx III	41
Length of ungual phalanx III	32
Width of ungual phalanx III	32

When skull material is found this genus *Boöchoerus* will probably either be replaced by *Daeodon* or will replace *Chaerodon*.

[2] Cope and Matthew, Tertiary Mammalia and Permian Vertebrata, 1915, pl. CX, fig. 3–8.

Daeodon minor new species

The type of this species is a pair of lower jaws with the deciduous dentition and molar 1 of the permanent set. With it are associated deciduous upper teeth and numerous bones of the skeleton, found in the *Stenomylus* quarry near Agate, Nebraska, in 1931 by the Amherst expedition. The age is Lower Harrison; the specimen is numbered 31–22.

The specimen was found while taking out remains of *Stenomylus hitchcocki* and was scattered along for some 15 feet, most of it coming from the cut made by

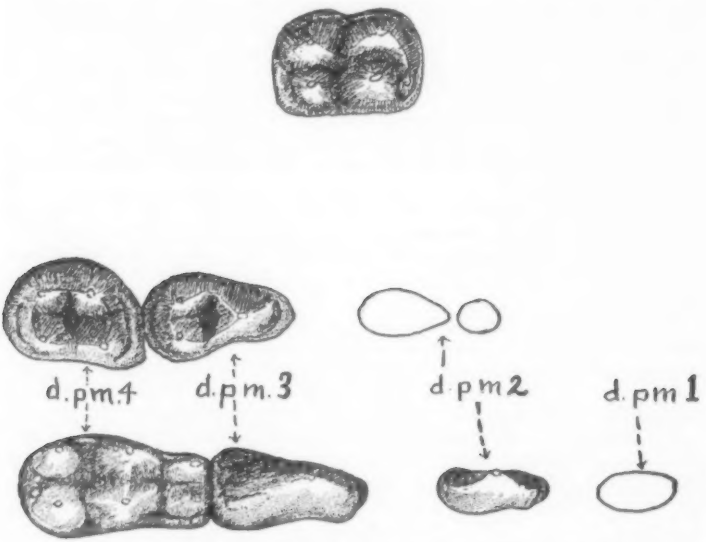

FIG. 3. DAEODON MINOR. UPPER, THE FIRST PERMANENT LOWER MOLAR, LEFT SIDE; LOWER, THE UPPER AND LOWER DECIDUOUS PREMOLARS FROM THE RIGHT SIDE; ALL ABOUT ¾ NATURAL SIZE

the Amherst party, but a fragment of the skull and the left lower molar 1 came from the adjoining cut made by the Harvard party. There are vertebrae, the scapula, radius, ulna, humerus, femur, tibia, toes, etc., all, however, so young that the epiphyses are lacking. On this account the skeletal bones are not described in detail, for the lengths and proportions had not become typical. Inasmuch, however, as there were no other animals at all like this mixed with the camel bones there can be no doubt that they all belong together.

Dinohyus is considered the last of the entelodont line and the largest of them all. The two known skeletons came from the *Diceratherium* quarry three miles

north of the *Stenomylus* quarry and in contemporaneous beds. Though so large, *Dinohyus* is one of the less specialized genera. This specimen must be assigned to *Daeodon*, as the anterior tuberosity on the lower jaw is entirely lacking and the posterior tuberosity is very small. The other species of this genus are both from the John Day beds and are 15 to 20 per cent larger. At the same time this form is 25 per cent smaller than *Dinohyus*.

Lower molar 1 of the permanent dentition is 31 mm. long and 21 mm. wide. It has four tubercular cusps, the two anterior ones higher and close together, the two posterior ones lower and separated by a wider and deeper valley (see fig. 3). There is a cingulum all around the tooth, except opposite the inner side of the inner anterior cusp. On the anterior internal corner there is a tiny isolated tubercle. I can not compare this with the other species of the genus; for *D. shoshonensis* has no teeth preserved, and this tooth is wanting on the jaw of *D. calkinsi*.

The deciduous teeth of entelodonts have not been described, except two for *Dinohyus*. Upper deciduous premolar 4 has a good deal the character of permanent molar 2, with four cusps rather crowded toward the center and a cingulum on the front and rear. Peterson describes the *Dinohyus* milk premolar 3, and this form has a similar, though smaller, tooth, with a single high anterior cusp and two posterior cusps.

Lower deciduous premolar 4 is a long tooth, with three pairs of cusps, the median pair the highest, and is unlike any permanent tooth. Premolar 3 of this milk set is long and two-rooted, with a single high cusp well to the front, suggestive of the one to follow in the permanent set. The same is true for deciduous premolar 2.

Of the limbs I can only say that, as far as young bones can be compared with those of an adult, the bones of this species compare more closely with those of *Dinohyus*, the same short stocky upper limbs (humerus and femur), with relatively long lower limbs (radius, tibia, and metapodials). In this material the radius and ulna are separate, probably a youthful character.

The importance of these new species is in showing that there was quite a wide range of entelodonts surviving into the Miocene, and to complete the history of this strikingly aberrant group it is desirable that a more complete search be made for these later forms.

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GENERAL NOTES

THE FISH-EATING HABITS OF PIZONYX VIVESI (MENEGAUX)

The little-known bat, *Pizonyx vivesi* (Menegaux), was discovered in December, 1900, by Diguet, beneath stones piled up along the shores of "Cardonal Island" in the Gulf of California, Mexico. The bats were found in company with a species of petrel (*Halocyptena microsoma* Coues) and were suspected by Diguet, but without evidence, of subsisting on the excrement of these birds. Miller and Allen (U. S. Nat. Mus. Bull. 144, p. 213, 1928), in speaking of this species, say, "While we are thus left in complete ignorance as to the animal's food habits it seems not improbable that the enlarged foot and claws, the relative freedom of the leg from the wing membrane, and the elongation of the cusps of the teeth may be associated with a diet consisting at least partly of fish. The resemblance of the leg, foot, and calcar to those of *Noctilio*, a bat which is well known to devour small fish, is obvious."

Although bats of this species had been collected subsequently at Islas Encantadas and Isla Partida in the Gulf of California, and at Guaymas, Sonora, nothing was learned concerning their food habits. It was the writer's privilege, while in the company of a party on Mr. J. R. Pemberton's yacht "Petrel," to visit Isla Partida in January, 1932, and to make further notes on the habits of this bat. We arrived at Isla Partida on January 9, and departed from the island on the following morning, remaining over night for the express purpose of determining the nature of the food of the bats.

On the afternoon of our arrival a colony of bats was located on a steep hillside and a number of specimens were collected from beneath the stones there. That evening I remained on the island hoping that I might see the bats emerge from their retreats; I watched until darkness had completely fallen, but saw no bats. I returned to the boat for the night, but landed on the island the following morning before daybreak. At this time the bats were all back in their retreats and could be heard squeaking over the entire hillside. This chorus continued until daylight when it gradually died down. The bats had come out too late in the evening and had returned too early in the morning for any observations on them to be made; however, two more were collected and killed immediately so that any food remaining in the stomachs might be preserved. Upon dissection the stomachs were found to be distended with finely chewed fish remains, confirming the supposition of Miller and Allen that these bats probably subsisted at least in part on fish. Dr. Evermann of the California Academy of Sciences has been kind enough to examine one of the stomachs and has identified the fish as belonging to the sardine tribe. Although we now have definite evidence that these bats, like *Noctilio*, eat fish, the manner in which they catch them is still somewhat of a mystery; however, there is little doubt that the specialized claws aid the animals in procuring their food.

The specimens of *Pizonyx* taken to date have all been found inhabiting rock

slides and crevices beneath stones. The late Donald R. Dickey visited Isla Partida on June 1, 1928, at which time he collected 67 specimens, many of which were young. In his field notes for that day, he describes the habitat of this bat as follows: "The first occupied crevice I opened up contained one least petrel and two bats (*Pizonyx vivesi*). All morning we kept finding the bats and both black and least petrels in the same crevices. In fact the best description of the bat retreats is to say that we found them only in typical rock-slide colonies of petrels. These mixed colonies differed somewhat—perhaps according to the size of the rocks and crevices—in the ratio of their three component species, but on the basis of the whole morning's work I would say the ratio was somewhere near: bats, 10; least petrels, 10; black petrels, 1. I scouted around, overturning rocks here and there on the open hillsides, but found no bat except in close contact with petrels."

During our visit to the island on January 9 and 10, 1932, the petrels were absent from their nesting grounds. Although most of the bats occupied crevices that had been used as nesting sites by petrels during the previous year a few were found beneath stones where petrels had not frequented. The steep hillside on which we found the colony of bats was strewn with lava rocks, many of which were piled upon one another. Cardon cactus (*Pachycereus pringlei*) was also distributed rather densely, for that type of cactus, over the hillside. The rocks were porous and easily overturned because of their light weight.

Bat guano was found in nearly all of the crevices examined. Some of the guano was brick red in color and some was black; the pellets being about 10 mm. in length and 3.5 mm. in diameter. Upon examination the guano proved to be made up entirely of fish remains, chiefly scales with an occasional small fish bone. This same type of guano was seen in crevices along a cliff on San Pedro Nolasco Island and it is quite probable that the bats inhabit this island also.

Each female of this species, so far as known, has one young at a time. On June 1, 1928, Dickey collected 29 adult females, two of which contained one embryo each. Each of 25 of the remaining 27 females was carrying one young which was attached to one of the two pectoral teats of the mother. At this time 11 adult males were collected. Quoting again from Mr. Dickey's field notes, ". . . . most of them [bats] had a single third-grown youngster clinging to one or other of their two pectoral teats. In other words they have one young each, born for the most part in May."

There may be partial segregation of sexes after the mating season, or at least during the time that the young are being carried by the mothers. Dickey collected 29 adult females and 11 adult males on June 1, whereas in January, 1932, we found the sexes in about equal numbers; often males and females were occupying the same crevice. Of the young that were collected in June, 13 were females and 12 were males.

When uncovered these bats did not attempt to fly away, but usually sought a deeper crevice if one was available. We turned over rocks most of the afternoon and only one bat flew away. The flight was quite regular and reminded me very much of the flight of *Antrozous*.

Perhaps the only predatory enemies that these bats have on Isla Partida are owls. There are no large snakes known from the island and no mammals other than the bats. Two owl pellets (burrowing owl?) picked up on Isla Partida on January 9, 1932, each contained the remains of a bat (*Pizonyx vivesi*). In addi-

tion to the bat remains both pellets contained small amounts of gravel and one of the pellets the remains of a small snake (spotted night snake, *Hypsiglena ochrorhynchus* Cope). The bones of the snake had withstood the action of the gastric juices much better than had those of the bats.—WILLIAM HENRY BURT, *California Institute of Technology, Pasadena, California.*

BREEDING OF THE HOARY BAT IN PENNSYLVANIA

One of the most interesting results of an intensive effort to add to our all-too-meagre information on the life-histories of the bats of the region was the discovery in the late spring and early summer of 1932 that the hoary bat, *Lasiurus cinereus*, breeds in the neighborhood of Birdsboro, Berks County, Pennsylvania.

The first specimen was taken on May 31 by Albert Mittower, one of a group of volunteer bat hunters collecting for the Reading Public Museum. This specimen was a large female containing two well-advanced embryos. She weighed 34.34 grams; the foetuses, both males, weighed 2.5 and 2.6 grams, respectively, and appeared to be within two weeks of birth, judging from their development and the known weight at birth of the large brown bat, *Eptesicus fuscus* (2.80–3.00 grams), and the little brown bat *Myotis lucifugus* (1.45 and 1.55 grams). In the case of the former the average ratio at birth of young to adult is .175, in the latter .200, so that I would expect the *L. cinereus* to weigh about 4.75 grams at birth, which agrees pretty closely with the data from later specimens.

This bat was flying at a height of 25 to 30 feet over an artificial pond, apparently accompanied by another of the same species. It was taken at 8:10 P.M., in the fading twilight.

A second specimen was taken by Samuel Wishnieski at 8:30 P.M., on June 21, at the same place. This too, was with another of the same species. On examination it proved to have recently nursed young.

On the following night, June 22, a third specimen was taken at 8:05 P.M. This also apparently had young, the four mammae showing evidence of recent nursing. Whether the young were clinging to the parent and were lost in the water before they were retrieved, or had been left hung up somewhere in the woods, we were unable to determine. It was also impossible to estimate the number of young, since all four of the nipples were apparently active in all of the specimens.

On June 23 a fourth specimen was taken at 8:05 P.M. This one had two male young clinging to her teats. They weighed 5.25 grams each, and were covered, on the back, with a very short, silky gray hair, shading from Ridgway's no. 9 gray on the neck to slate gray on the lower back and interfemoral membranes. Their eyes were as yet unopened, from which fact I infer that they were less than a week old.[1] Fortunately this last specimen fell close to the boat and was picked up with one of the young still attached. The other became detached and fell into a bed of algae, where it was promptly recovered.

The evidence cited would place the birth of the young in Pennsylvania between June 12 and 20. Former published references to the parturition of this species are a statement by Seton (1909) that "They are born, apparently, the last week in

[1] Rollinat and Trouessart state that *Vespertilio murinus* [=*Myotis myotis*], a large European species, opens its eyes most commonly on the fifth or sixth day, and it is hardly likely that the hoary bat takes more than a week.

May," another by Nelson (1918) that they are born in June, and a third by Vernon Bailey (1926) recording two females, each containing two large embryos, taken in North Dakota, the first on June 12, 1833, at Fort Clark, by Maximilian and the second on June 20, 1913, "at the agricultural college."

Statements that the hoary bat is always solitary are not borne out by our experience, as two or more were frequently seen hunting together. On June 22 five individuals were seen within a short time, and on June 23, at least three.

It is also interesting to note that the specimens taken were all breeding females, which is in accord with observations on the sexual segregation of other bats during the period of parturition. Incidentally it apparently establishes a southernmost breeding record for the species east of the Alleghenies, although in the Mississippi Valley we have records indicating probable breeding from as far south as Bloomington, Indiana (McAtee); Lexington, Kentucky (U. S. Biological Survey); and Lawrence, Kansas (Hall).

Curiously enough, the locality where these bats were taken is considered by all the faunal-map makers as the upper edge of the Carolinian Zone, while *Lasiurus cinereus* has long been considered a distinctly Boreal species.

The body of water over which these bats were seen and the specimens collected is an artificial pond of not over four acres in extent. It supports a scattered growth of spatterdock and rushes and is almost entirely surrounded by a mixed pine and deciduous woodland, with some fields adjacent and moderately high, wooded hills on either side.

Data on the specimens follow:

	WEIGHT	LENGTH	TAIL	FOREARM	EXTENT	
No. 823. May 31, 1932	34.34	140	56	55	412	2 male embryos
No. 848. June 21, 1932	30.10	145	64	54	411	mammae functional
No. 850. June 22, 1932	25.10	137	60	56	415	mammae functional
No. 852. June 23, 1932	27.10	137	60	55	421	bearing 2 male young
No. 853. Young June 23, 1932	5.25	63	16	22	145	
No. 854. Young June 23, 1932	5.25	alcoholic				

The stomach contents of the first specimen, as determined by Francis M. Uhler of the U. S. Biological Survey, consisted of a large stink-bug, *Nezara* probably *hilaris*, and a mosquito, possibly *Culex*.

Mr. W. H. Liebelsperger, of Fleetwood, recently wrote me that on June 15, 1907, he saw a hoary bat suspended among the foliage of a tree on the slope of the Pinnacle in this county.

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—Earl L. Poole, *Reading Public Museum and Art Gallery.*

THE TYPE LOCALITY OF URSUS LOTOR LINNÉ

In defining the type locality of the North American raccoon *Ursus lotor* Linné as the former village of Raccoon, at or near the present town of Swedesboro, New Jersey, we (Journ. Mamm., vol. 11, no. 4, p. 453, Nov., 1930) overlooked the fact that the subject had already been dealt with by Thomas (Proc. Zoöl. Soc. London, March, 1911, p. 140). Basing his reasoning largely on Linné's statement (Kongl., Svenska Vetenskaps Acad. Hand., vol. 8, 1747, p. 278) that the raccoon was called "Ispan" by the Swedes in Pennsylvania he fixed that state as the type locality. Linné's description, as we have already pointed out (l.c.), was based in part upon Kalm's accounts (Travels into North America [English edition], vol. 1, 1772, pp. 76, 360) of the animal recorded at Germantown and Philadelphia, Pennsylvania and Raccoon, New Jersey, which according to the translator was considered "a place which is properly its native country." We regarded our selection of Raccoon, New Jersey as particularly appropriate but there is no valid reason for not accepting the previous fixation of the type region by Thomas. For greater precision, however, in view of Kalm's definite record we now propose Philadelphia, Pennsylvania, as the type locality of *Ursus lotor* Linné (= *Procyon lotor*).—E. W. Nelson and E. A. Goldman, *U. S. Biological Survey.*

CONCERNING ATELES GRISESCENS

In 1865 Gray (Proc. Zool. Soc. London, 1865, p. 732) described a gray spider monkey from a captive animal of unknown origin. The brief and unsatisfactory history of the species is given by Elliot in his "Review of the Primates" (Vol. 2, 1913, p. 37) but as is so often the case he has little to suggest concerning the validity of the name or the affinity of the animal although, of course, he had seen the type in London.

I have long known that gray spider monkeys occasionally turn up in the Panama market, and latterly my interest has been greatly increased in trying to identify some monkeys for my friend, Dr. Herbert Clark, Director of the Gorgas Memorial Institute. He has been studying monkeys in the field and in the laboratory in connection with his now classic work on simian malaria, and he has seen and secured gray spider monkeys himself. I have a gray fully adult skin and skull before me which came from Chepigana in Darien and which agrees well with the description of *A. grisescens*. From what Clark has learned these monkeys are common in the lower basin of the Tuyra River. They thus seem to occur in a part of the range of *A. dariensis* Goldman, which is coal black. Goldman's monkey, while black, has not the facial physiognomy of the North American black spider

what harsher pelage than winter-taken specimens); the texture of the pelage is, I believe, a character to be considered in this particular case. The skull of *neglectus* is lighter and more rounded throughout and is relatively longer and narrower than that of *pascalis*. Particularly distinctive are the maxillary portions of the zygomatic arches. These are relatively weak in *neglectus*, broad in *pascalis*. Also the premaxillae project farther beyond the posterior termination of the nasals in *neglectus*.

In the above particulars the Mount Piños specimens agree with topotypes of *neglectus* rather than with those of *pascalis*. Specimens from Fort Tejon and Cuddy Valley (altitude 6000 feet) show intergradation between *pascalis* and *neglectus*. Two specimens from Fort Tejon are considered to be *pascalis* because they possess more of the characters of that form than of *neglectus*, whereas the Cuddy Valley specimens, although in some instances approaching *pascalis* in coloration, display more of the characters of *neglectus*, especially in the skull.

In the San Gabriel Mountains *neglectus* may possibly intergrade with *pallescens*. Seven specimens from Bouquet Canyon seem to show this intergradation. Six of these specimens, although not typical, are closer to *neglectus* while one specimen (probably from a lower level, but unfortunately the altitude is not given) agrees both in skin and skull characters with *pallescens*.

Accordingly the range of *neglectus* may now be given as the higher ridges (3500 feet and above) from San Antonio Peak to Mount Piños. Inasmuch as integradation is evident between *neglectus* and forms of *bottae* I suggest that *neglectus* be reduced to subspecific rank and be considered as a high mountain form of the species *bottae*. Specimens of *Thomomys bottae neglectus* have been examined in the Dickey collection and in the collection at the Los Angeles Museum from the following localities in the San Gabriel Mountains: Bear Flat, 2; Look-Out, near Camp Baldy, 2; Camp Baldy, 2; San Antonio Canyon, altitude 6400 feet, 5; Mount Islip, altitude 7500 feet, 4; Bouquet Canyon, 6. From Mount Piños they have been examined from the following localities: Mount Piños, altitude 8300 feet, 2; Cuddy Valley, altitude 6000 feet, 19; Cuddy Valley, altitude 5000 feet, 1.

In the above connection it was necessary to examine specimens from the lowlands surrounding the range of *neglectus*. Through the courtesy of Mr. George Willett of the Los Angeles Museum I was permitted to examine the excellent material in that institution. This material from critical localities made it possible to determine fairly definitely the limits of the ranges of *bottae* and *pallescens* in this particular area.

According to the material examined *pallescens* is a poorly defined race, the range of which is restricted to the foothills of the San Gabriel Mountains. It intergrades with *bottae* at Grapelands (type locality of *pallescens*) and west along the south side of the San Gabriels. North of the San Gabriels, at the south end of Antelope Valley, it grades toward *mohavensis*. Specimens from Saugus and various stations along Mint Canyon to Palmdale and Llano are considered to be *pallescens* (von Bloeker, Journ. Mamm., vol. 13, pp. 76–77, 1932).—WILLIAM HENRY BURT, *California Institute of Technology*.

THE NAME OF THE SAN MARTIN ISLAND MOUSE—A CORRECTION

We are indebted to Doctor E. Raymond Hall for directing our attention to the fact that *Peromyscus maniculatus martinensis* Nelson and Goldman (Journ.

Washington Acad. Sci., Vol. 21, No. 21, p. 534, Dec. 19, 1931), from San Martin Island, Lower California, is a synonym of *Peromyscus exiguus* J. A. Allen (Bull. Amer. Mus. Nat. Hist., Vol. 10, p. 157, Apr. 12, 1898), which was described from the same island. The latter name was placed by Osgood (North American Fauna No. 28, p. 99, Apr. 17, 1909) in the synonymy of *Peromyscus maniculatus geronimensis* J. A. Allen, a cirummstance that should not have been overlooked by us. Osgood, (l.c., p. 100) pointed out the greater average width of the nasals in the San Martin Island animal as compared with typical *geronimensis*, and this and the other differential cranial features we mentioned (l.c., p. 535), are still regarded by us as sufficiently distinctive to warrant a separate name. We would, therefore, revive the name *Peromyscus exiguus* J. A. Allen, but reduce it to subspecific status, as *Peromyscus maniculatus exiguus* J. A. Allen.—E. W. Nelson and E. A. Goldman, *Biological Survey, U. S. Department of Agriculture.*

BANG'S DISEASE IN THE YELLOWSTONE NATIONAL PARK BUFFALO AND ELK HERDS

It has been noted for the past three or four years that a number of buffalo cows aborted their calves, and Bang's disease (infectious or contagious abortion) has been suspected of being the cause.

"Abortion disease of cattle is widely distributed and is of great economic importance. It is caused by a germ known as the *Bacillus abortus* (Bang). The disease is commonly introduced into healthy herds by the purchase of affected cows and pregnant heifers."

"The malady is commonly acquired through the mouth by consuming feed and drink contaminated with the germs, by licking affected animals to which the germs adhere, contaminated mangers or other objects. Proof is lacking that bulls transmit the disease through the act of service."[1]

In 1930, the Bureau of Animal Industry detailed Dr. William Logan of its staff to secure serum samples from the buffalo herd in order to determine if Bang's disease was prevalent. Because of the difficulty of getting blood samples from live buffalo, Dr. Logan got but five samples, three of which reacted positively to the agglutination test for *B. abortus*.

At the time of butchering the surplus buffalo, December 3 to 10, 1931, 110 blood samples were taken and tested by the "rapid plate" test at the Wild Life Research Laboratory, Yellowstone Park, and by both the "plate" and "tube" test at the Montana Veterinary Research Laboratory, Bozeman, Montana.

The results of these 110 tests are as follows: 58 were positive, 27 were negative and 25 suspicious. Of the pregnant, lactating animals 24, or 57 per cent, tested positive. Of the pregnant, non-lactating animals 8, or 73 per cent, were positive. Of the non-pregnant, lactating ones 11, or 40 per cent, were positive. The non-pregnant, non-lactating tested 5, or 45 per cent, positive. Of the males, three steers were positive, seven bulls positive and five bulls negative.

A check was kept on the remaining 95 buffalo slaughtered, for pregnancy and lactation which, combined with the foregoing, totals as follows:

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[1] Buck, John M., 1927, Infectious abortion of cattle, U. S. Dept. Agric., Farmers' Bull. No. 1536.

	Buffalo slaughtered	*Percentage of females*
Bulls	14	
Steers	6	
Pregnant, lactating cows	97	52.1
Pregnant, non-lactating cows	22	11.8
Non-pregnant, lactating cows	45	24.2
Non-pregnant, non-lactating cows	20	10.8
Non-pregnant (?) cow	1	0.6
Calf	1	0.5
Total all animals slaughtered	206	100.0

This shows that 119 cows were pregnant, of which 97 nursed calves the past season; 65 were non-pregnant, but 45 of these had nursed calves.

The total number of cows in the herd is not known, so it is impossible to apply these ratios to the entire herd and compare with the number of calves actually reared during the season.

One retained fetus was found in the 174 cows examined. In cases of this kind the fetus became mummified because of the interference with nutrition from the maternal tissue by bacterial infection, probably *B. abortus*. Following mummification the fetal tissues were gradually absorbed until at the time the mater was slaughtered only the bony tissue remained. The bones also would have become absorbed in time.

Since a complete history of this buffalo herd is lacking, including such factors as original numbers, sex and age ratios, number, sex and age ratios each year since establishment, losses from other sources by years, and the date when Bang's disease was introduced in the herd, it is impossible to show now the rôle the disease has played.

A few domestic cattle were maintained on a part of the buffalo range until about 1919 and bulls were imported for breeding these cattle. This is the only contact that the buffalo have had with domestic stock and it is entirely probable that the buffaloes became infected from these cattle.

The writer recommends a further study of the effect this disease is having on the buffalo herd. Also the initiation of practical control measures such as feeding hay from racks instead of from the ground, destruction of aborted fetuses, and slaughtering of infected animals to reduce any surplus that may exist in the future.

A great variance in the size of the fetuses was noted, which indicates a long breeding season. This is probably due to the fact that this herd has been artificially fed during the winters for the past 25 years, thus lessening the dependence upon favorable seasonal conditions for birth of young.

As a part of the elk herd uses the same range as the buffalo some tests from these animals were made. Thirty-five blood samples were taken from elk wintering in the vicinity of Mammoth, 30 miles from the buffalo range. Two of these showed contact with the *B. abortus* and were classed as suspicious. Thirty-three were negative.

Thirty-two samples were taken from elk ranging in proximity to the buffalo range. Of these three were positive, eight suspicious and 21 negative. These tests indicate that the disease has become established in the elk herd and will be another factor in further depleting the numbers of these animals.—W. M. Rush, *Yellowstone National Park, Wyoming.*

RECENT LITERATURE

Smith, G. Elliot. THE SEARCH FOR MAN'S ANCESTORS. The Forum Series, no. 16, pp. viii + 56, pls. 6, text figs. 6. Watts & Co., London, October, 1931.

No one can fail to enjoy a reading of Doctor Smith's little volume, in which the remarkable story of the search for man's ancestors is told with all the author's usual persuasive tact and charm.

Unfortunately the smooth flow of this narrative, on its taxonomic side in particular, seems to depend too much on a studied ignoring of hampering obstacles, three of which are worthy of comment because of their wide import.

In the first place the "Java man" and the "Piltdown man" are confidently assigned to rather definite positions in the history of human evolution in spite of the fact that each is admitted to be the subject of huge and unending controversy. Moreover, the reader is not told, as in fairness he should be, always to remember that both of these much discussed fossils lack the parts of the skeleton that are, perhaps, the most essential of all for the tracing of human descent, namely, the foot, the pelvis, and the basal part of the skull.

Next we find an intrepid disregard of the notorious circumstance that the range of individual variation in the skeletons of the larger primates, both human and non-human, is so excessive that it renders all general conclusions questionable when they do not rest on good series of perfect specimens. And, consistently with this neglect of a grave cause of perplexity, the text of the book abounds in far reaching but profitless generalizations based on the few and fragmentary fossils that have thus far been brought to light.[1]

Finally the author pays no attention to the stumbling blocks that his hypothesis of human descent encounters in the circumstance that both man and the Tertiary great apes that he treats (pp. 43–55) as possible forerunners of humanity are giants. To make this point clear some explaining, perhaps, is necessary.

The fact that man and all of the great apes (under this term I do not include the gibbon family) are in the advanced evolutionary stage known as gigantism can hardly be doubted by anyone who will take the trouble to survey the living members of the order Primates as a whole. For he will then see that this group of mammals is made up of hundreds of kinds whose size ranges from that of squirrels to that of bird dogs, of a dozen or two that are somewhat larger, and of four whose great bulk makes them wholly exceptional,—gorilla, orang, chimpanzee and man. Obviously it is the majority and not one of the exceptions that must set the standard of size.

The records of paleontology show that giants have arisen in many groups of mammals. More significantly they show that these overgrown creatures com-

[1] As a good example I may refer to the "ocular demonstration of the simian resemblances" of the Piltdown braincase (fig. 2 and accompanying verbal exposition, pp. 25–26).

monly exist during short intervals, geologically speaking, and then become extinct without giving rise to new lines of development. Their racial life seems to have advanced beyond its period of plasticity. It is true that a gigantic stock dating from one age is often represented in a later age by a modified successor of its own general kind—as one elephant by another; but in no single recorded instance have we the fossils to demonstrate that an earlier mammalian giant has been modified into a later giant of an obviously different type—as a mastodon into a modern elephant or a great sabertooth into a modern great cat. So complete is the absence of evidence that the mere suggestion of such transitions would not be seriously put forward. Nevertheless the evolutionary anomaly implied by either of the two examples just mentioned is probably no greater than the one implied by the belief that a great ape, its evolutionary trends stabilized in gigantism, could change, under stress of altering environment, into such an essentially different kind of giant as man.

It might, perhaps, be urged that we should, in the absence of knowledge to the contrary, be prepared to admit that some such unusual thing may have happened on the human line of descent, as Darwin once guessed it had; but the proper reply to this argument would be to insist that the occurrence of no unusual event in zoological history can be demonstrated on the basis of an alluring surmise and a few bones about whose exact nature it has been impossible for students to agree.

Though the difficulty-ignoring method is most conspicuous in the taxonomic parts of Doctor Smith's work it occasionally appears in the historical parts as well. Thus, on page 24 we are told that scepticism with regard to the association of the different elements of the original Piltdown find as parts of one animal was done away with when Dawson "found fragments of a second [human] skull precisely similar to the first, but in a patch of gravel two miles distant . . . and with these a molar tooth like those set in the supposed ape's jaw . . .," but we are nowhere told a word of the blighting and as yet unanswered criticism to which the generally accepted interpretation of this second "find" has been subjected.[2] The present volume furnishes one more illustration of the ease with which a strong and sincere conviction joined with literary skill can always cloud the main issue—here the correct taxonomic interpretation of some imperfect fossil bones.—*G. S. Miller.*

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[2] Hrdlička, Amer. Journ. Phys. Anthrop., vol. 5, p. 346, December, 1922, and Smithsonian Misc. Coll., vol. 83, p. 87, July 24, 1930.

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COMMENT AND NEWS

Dr. Hermann von Wechlinger Schulte, anatomist, and a charter member of the American Society of Mammalogists, died in Omaha, Nebr., July 13, 1932, at the age of 55 years. He was born in Utica, N. Y., Aug. 9, 1876, the son of Bernard and Julia Low Schulte. He received his education at Trinity College in Hartford, Conn., graduated in medicine in the College of Physicians and Surgeons, Columbia University, in 1902, and served two years as an Interne at the Presbyterian Hospital in New York. From 1904 to 1916 he taught anatomy and engaged in research work at Columbia under the leadership of Dr. G. S. Huntington.

In 1916 Dr. Schulte was appointed Professor of Anatomy at Creighton University, Omaha, Nebr., and two years later Dean of the Medical School. It was here that he demonstrated his ability as a teacher and research worker and inspired not only students and graduates but faculty members as well.

Dr. Schulte's anatomical research work in mammalogy was varied and important. His principal work was a monograph on the anatomy of the Sei whale (*Balaenoptera borealis*). He also published papers on the anatomy of other whales and of *Scutisorex*, on the venous system of marsupials and monotremes, the development of the great veins and hepatic circulation in the cat, and the histogenesis of the salivary glands. Beside being a member of the American Society of Mammalogists he held membership in the American Museum of Natural History, the New York Zoological Society, and a number of other scientific organizations, chiefly anatomical. He was prominent in sociological work in his community and was widely known as a leader in the field of anatomical research.—*T. S. P.*

ACTIVITIES OF THE AMERICAN COMMITTEE FOR INTERNATIONAL WILD LIFE PROTECTION DURING THE PAST YEAR FOR THE AMERICAN SOCIETY OF MAMMALOGISTS

(May 21, 1932)

The American Committee for International Wild Life Protection is in the third year of its activities. The American Society of Mammalogists has an official representative on our advisory board, Dr. Joseph Grinnell of Berkeley, California.

The purposes for the foundation of this Committee were to have an organization to coöperate with foreign governments and institutions working for international wild life protection, particularly the Society for the Preservation of the Fauna of the Empire in London, and the Office for International Nature Protection at Brussels; promoting of national parks and game reserves, similar to our own, outside of the United States and its possessions; and effectively to unify and represent the growing sentiment in all parts of this country in favor of protecting forms of wild animal and plant life throughout the world, wherever they may be threatened with extinction.

During the past year the American Committee has collected $5500 which was pledged at the annual meeting of 1930 through the generosity of certain members of the Committee and a few friends. This sum was forwarded to the President of the International Office for the Protection of Nature at Brussels.

The Committee has issued its first scientific publication in the form of a report showing the relation of game to the spread of tsetse fly-borne diseases in Africa. This investigation was conducted for us by Dr. R. P. Strong, Dr. J. C. Bequaert, and Dr. L. R. Cleveland of the Department of Tropical Medicine at the Harvard Medical School. It was made possible through the generous help received from the New York Zoölogical Society and Mr. George D. Pratt. This report constitutes the first attempt to sum up the results of an investigation that has been going on for many years in different parts of Africa. The study has a direct bearing on the problem of whether it will be possible to preserve existing wild life in the tsetse fly-infected regions, where it is constantly encroached upon by advancing civilization. The publication has been widely distributed in Europe and Africa and has been well received.

The American Committee has conducted an investigation of the present status of the chinchilla, a rodent (inhabiting certain highlands in Chile, Peru, and Bolivia) that is actively hunted because of the great value of its fur and, in consequence, is in great danger of extinction. Along these same lines we are at present engaged in gathering information about the status of the musk-ox herds in Canada and Greenland.

After a year of preparation, a map has been drawn showing the national parks and game reserves in the British, French, Belgian, and Portuguese colonies in Africa. Information as to the various forms of wild life protected in these regions is now being gathered, as well as other notes concerning their area and distribution.

During the past year Major Hington's report, published by the Society for the Preservation of the Fauna of the Empire, was an important contribution to the problem of preserving the indigenous fauna in the parts of East and South Africa governed by English-speaking peoples.

Last July (1931) an important conference, "The International Congress for the Protection of Nature," was held in Paris, at which a great many nations were represented. The Prime Minister of Great Britain, in his special message to the Congress, concluded as follows:

"*International action* is required to supplement the efforts of *individual Governments*, and it is for this reason that His Majesty's Government welcomes the opportunity of participating in the work of this Congress. Any recommendations that the Congress may make for more effective international co-operation in the protection of Nature are assured of most careful and sympathetic consideration by His Majesty's Government." This official recognition of the importance of international action in wild life protection is a great stimulus to the work of our Committee.

Among the excellent resolutions passed at the Paris Congress was one urging the prohibition of the importation into different countries of such animals or parts thereof for which there was in the country of origin an export prohibition in force. We were pleased to note that in the United States Tariff Act of 1930, Sec. 527, there is a provision carrying out this recommendation which should serve as substantial assistance to foreign governments in the protection of their wild life.

Another matter of importance in international protection has been the signing by the United States of the Treaty for the Protection of Right Whales. For the past two years our Committee has been coöperating with the special committee

appointed by the American Society of Mammalogists in urging government support of this important international measure. It is, therefore, a great satisfaction to be able to report that the treaty was signed on March 31, 1932, at Geneva.

During the past year the Secretary visited a number of foreign countries, in every one of which he found an increasing interest in matters of international nature protection. This was particularly true in Japan and Russia. In Holland, Mr. Van Tienhoven's work for the preservation of nature and the spirit of conservation which he has built up among the Dutch people is unique among the countries of Europe. In Brussels, the International Office for the Protection of Nature was being very ably run by Dr. Graim, in the absence of Dr. Derscheid who was in Africa on government service. This Office contains a complete library and documentary file of all matters that have to do with wild life protection in every corner of the globe.

It has been reported to our Committee that the new Government in Spain intends to protect strictly the former royal herd of Spanish ibex, which is the only means of saving this species from extinction.

The Italian Government has been active during the past year in inaugurating parks and passing laws protecting its fauna and flora.

The American Committee is deeply grateful for the moral and financial backing received from loyal friends and member organizations, and hopes that this support may be continually increased in proportion to their activities, so that a broader understanding of what we are doing may be spread among the people of this country interested in promoting international wild life protection.

Respectfully submitted by,

HAROLD J. COOLIDGE, JR.
Secretary of the Executive Committee

Executive Committee:

JOHN C. PHILLIPS, *Chairman*, Boone & Crocket Club
GEORGE D. PRATT, American Museum of Natural History
KERMIT ROOSEVELT, New York Zoölogical Society
ARTHUR S. VERNAY, Society for the Preservation of the Fauna of the Empire
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ALEXANDER WETMORE, Smithsonian Institution

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